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ECONOMIC IMPACT OF CLOSING ZION NUCLEAR FACILITY.(U)
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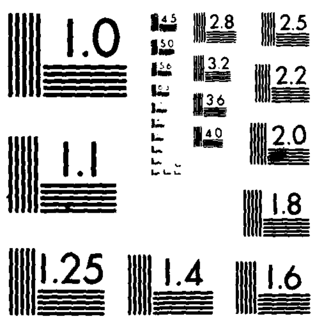

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REPORT BY THE

Comptroller General OF THE UNITED STATES

Economic Impact Of Closing Zion Nuclear Facility

The Zion nuclear plant's close proximity to the heavily populated Chicago area has raised questions about the safety of its continued operations.

Zion's loss would reduce power supplies below levels considered adequate to maintain reliable service. Should the demand for electricity be less than now projected, the impact would be less severe; however, should plants now under construction be delayed, the impact would be more severe.

Purchased power from other utilities is the most immediate way to replace Zion's power, but the existing transmission network may be a limiting factor.

New non-nuclear plants can be constructed to replace Zion, but they would not be available before the 1990s. Measures to reduce electric demand also have long-term potential, although their effectiveness will depend on costs, customer acceptance, economic conditions, and regulatory and other governmental policies.

GAO discusses the pros and cons of closing the Zion facility.

UNITED STATES GENERAL ACCOUNTING OFFICE

EMD-82-3
OCTOBER 21, 1981

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COMPTROLLER GENERAL OF THE UNITED STATES
WASHINGTON D.C. 20548

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The Honorable John D. Dingell
Chairman, Committee on Energy
and Commerce
House of Representatives

The Honorable Richard L. Ottinger
Chairman, Subcommittee on Energy
Conservation and Power
Committee on Energy and Commerce
House of Representatives

This report was prepared in response to your joint request of April 10, 1980, when serving as Chairman, and Ranking Majority Member, Subcommittee on Energy and Power, House Committee on Interstate and Foreign Commerce. The report discusses the comparative costs of terminating operations at the Zion nuclear electric-generating facility near Chicago, Illinois, versus adding the necessary safety requirements to protect the large surrounding population. It also discusses the financial and power supply impact that termination would have on the Commonwealth Edison Company and its customers.

As requested, we did not obtain agency comments on the matters discussed in the report. As arranged with your offices, unless you publicly announce its contents earlier, we will not release this report until 7 days from the date of the report.

Milton J. Socolar
for Comptroller General
of the United States

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REPORT OF THE
COMPTROLLER GENERAL
OF THE UNITED STATES

ECONOMIC IMPACT OF CLOSING
ZION NUCLEAR FACILITY

D I G E S T

Concern over the safety of large numbers of people living in close proximity to nuclear powerplants has been accompanied by questions relating to the economic effects that would likely result if the plants were closed. GAO's analysis of the potential economic impact of closing the Zion nuclear facility, 40 miles north of Chicago, disclosed that:

--Zion's nuclear power was generated at about one-fourth to one-third the cost of that generated by coal-fired units in the Commonwealth Edison system.

--Unless replacement capacity could be found, the loss of Zion's 2,080 megawatts of capacity would reduce Commonwealth Edison's reserves below levels that it considers adequate to maintain reliable service.

--To the extent it is available, purchased power from other utilities would be the most likely way to replace Zion's power.

--Commonwealth Edison's production costs would increase by over $300 million the first year without Zion.

--Increases in annual short-term revenue requirements would range from $47 million to $356 million, depending on assumptions used.

--Revenue requirement increases through the year 2000 could total between $16.6 billion and $18.2 billion.

--Leaving Zion in service but limiting its operation to 70-percent power would also increase costs, but to a lesser degree.

GAO's review was conducted at the request of the former Chairman, and Ranking Majority Member, Subcommittee on Energy and Power, House Committee on Interstate and Foreign Commerce. (See app. I.)

THE ZION POWERPLANT IS AN ECONOMICAL SOURCE OF POWER

The Zion nuclear units provide an economical source of energy for customers of Commonwealth Edison. Generating costs in 1980 were 0.7 cent per kilowatt hour at Zion as compared with the company's coal-fired generation costs of 2.5 cents and oil-fired (steam) costs of 6.4 cents. (See p. 8.)

Total costs include items such as depreciation expense, taxes, and interests, which increase the per unit costs. Although these costs are common to all generating facilities, the per unit costs are greater for the fossil-fired generating plants than the Zion units. This results primarily because the nuclear units have a higher average kilowatt-hour output. (See pp. 9 to 11.)

Continued use of the Zion units will require expenditures in the next few years that would not be required for non-nuclear generating units. Funds will be needed for safety-related modifications required by the Nuclear Regulatory Commission and for radiological emergency preparedness measures. Although total costs are uncertain, planned expenditures over the next few years will total about $70 million. Future Nuclear Regulatory Commission requirements could add substantially to this amount. (See pp. 12 to 16.)

ADEQUATE POWER SUPPLIES WOULD NOT BE CERTAIN WITHOUT ZION

The 11.8 billion kilowatt hours of energy provided by the Zion units in 1980 accounted for 19 percent of Commonwealth Edison's generation. The loss of these units--12.3 percent of the company's summer generating capacity--could pose a threat to continued energy supplies unless replacement power can be obtained. (See p. 1.)

The company's peak load estimates for the period 1981-86 indicate reserve margins will range from 14.4 percent to 25.1 percent with Zion in service. The loss of Zion's 2.080 megawatts of capacity would result in reserve margins dropping to as low as 0.6 percent, far below the 15 percent considered necessary

by the utility for adequate electric service reliability. Unsatisfactory reserve levels could extend through 1990. (See pp. 48 and 51.)

Future reliability without Zion would depend on Commonwealth Edison's ability to purchase replacement power, its actual load growth rates, and timely completion of powerplants now under construction. Power purchases of between 300 and 2,380 megawatts would be required for the company to maintain its targeted reserve margin. The most critical years are 1981 to 1984 when between 1,350 and 2,380 megawatts would be required. If the rate of load growth is less than currently projected, the reserve deficiencies would be less severe and of shorter duration. On the other hand, should completion of the large nuclear units now under construction be delayed, Commonwealth Edison's ability to meet peak loads would be further reduced. (See pp. 57 to 59.)

<u>PURCHASED POWER IS THE MOST IMMEDIATE ALTERNATIVE</u>

To the extent other utilities have power to sell, purchasing power would be the most immediate way to replace Zion's capacity. Commonweath Edison would need to buy as much as 2,080 megawatts of additional firm power, and this amount could be available considering the reserves of surrounding utilities. This magnitude of purchase, however, would not only strain Commonwealth Edison's transmission system but would also reduce power reliability in Wisconsin. If the company's current plant construction program is delayed, purchased power requirements could be further increased. (See pp. 55 to 59.)

If the capacity deficit caused by closing Zion could not be made up through purchases or some other measures, Commonwealth Edison would have to operate its system with reduced reserves. This could entail expensive emergency purchases as well as load reduction actions that would affect customer service. (See pp. 59 and 60.)

Other alternatives have potential for the long term, but would not help in the early

1980s when the loss of Zion would be most critical. New plants can be built, but long construction lead times would preclude their availability before 1990. The loss of Zion might be made up through demand reduction measures such as conservation, load management, and cogeneration. Over the long term, reasonably attainable savings from these measures will depend on cost effectiveness, customer acceptance, economic conditions, and regulatory and other governmental policies. (See pp. 60 to 65.)

INCREASED REVENUE REQUIREMENTS WILL BE NEEDED WITHOUT ZION

Closing Zion would require Commonwealth Edison to replace the lost energy primarily with purchased power and with increased coal- and oil-fired generation. Production costs--fuel, operation, and maintenance--would increase by about $313 million the first year, and by varying amounts in the years thereafter. (See pp. 25 and 26.)

Total incremental revenue requirements include production costs plus other costs that would be affected by closing the Zion plant--insurance, depreciation, construction, taxes, and return on investment. Depending on assumptions used concerning growth rates and the costs that utility regulators allow Commonwealth Edison to recover, estimated annual revenue requirement increases would range between $47 million and $356 million over the years 1981 through 1986. Based on the company's current sales projections, the revenue requirement increases would add between 0.15 and 0.55 cent to the cost per kilowatt hour sold. Not included in these estimates are decommissioning or spent fuel disposal costs, which would probably be accelerated with Zion out of service. (See pp. 27 to 34.)

Long-term revenue requirement increases without Zion reflect increased costs resulting from constructing replacement capacity. Total revenue requirement increases for the years 1981 through 2000 are projected at $18.2 billion assuming 3-percent annual load growth and $16.6 billion, assuming 1.5-percent

growth. Revenue requirement increases are greatest during the 1990s due to the construction cost effects and the escalation of costs to account for inflation. (See pp. 36 to 38.)

LIMITING ZION TO 70-PERCENT POWER WOULD INCREASE COSTS BY LESSER AMOUNTS

Continued operation of the Zion units at a reduced power level is an option to total shutdown. With Zion limited to 70 percent of maximum power, estimated annual revenue requirement increases ranges between \$54 million and \$91 million over the years 1981 through 1986. Over the years 1981 through 2000, total revenue requirement increases are projected to total between \$4.3 billion and \$5.3 billion. (See pp. 40 to 43.)

AGENCY COMMENTS

As requested by the Chairman, Committee on Energy and Commerce, and the Chairman, Subcommittee on Energy Conservation and Power, Committee on Energy and Commerce, we did not obtain agency comments.

Contents

ABBREVIATIONS

DOE	Department of Energy
FEMA	Federal Emergency Management Agency
FERC	Federal Energy Regulatory Commission
GAO	General Accounting Office
ICC	Illinois Commerce Commission
kWh	Kilowatt hour
LOLP	Loss of load probability
MAIN	Mid-America Interpool Network
NRC	Nuclear Regulatory Commission

CHAPTER 1

INTRODUCTION

The former Chairman, and Ranking Majority Member, Subcommittee on Energy and Power, House Committee on Interstate and Foreign Commerce, requested that we assess the comparative costs of terminating the operation of the Indian Point, New York, and Zion, Illinois, nuclear generating facilities versus the costs of complying with safety requirements necessary for adequate protection of the adjacent population. These two facilities were identified because of their proximity to the major population centers of New York and Chicago. This report discusses the results of our analyses for the Zion nuclear generating station.

ROLE OF ZION IN GENERATING ELECTRICITY FOR NORTHERN ILLINOIS

The Zion nuclear station is located about 40 miles north of Chicago on the shore of Lake Michigan. Owned by Commonwealth Edison Company, Zion consists of two identical pressurized water reactors furnished by Westinghouse Electric Corporation. Under construction since 1968, Zion's two units began operation in 1973 at 85 percent power. In June 1976, NRC authorized Zion to operate at full power.

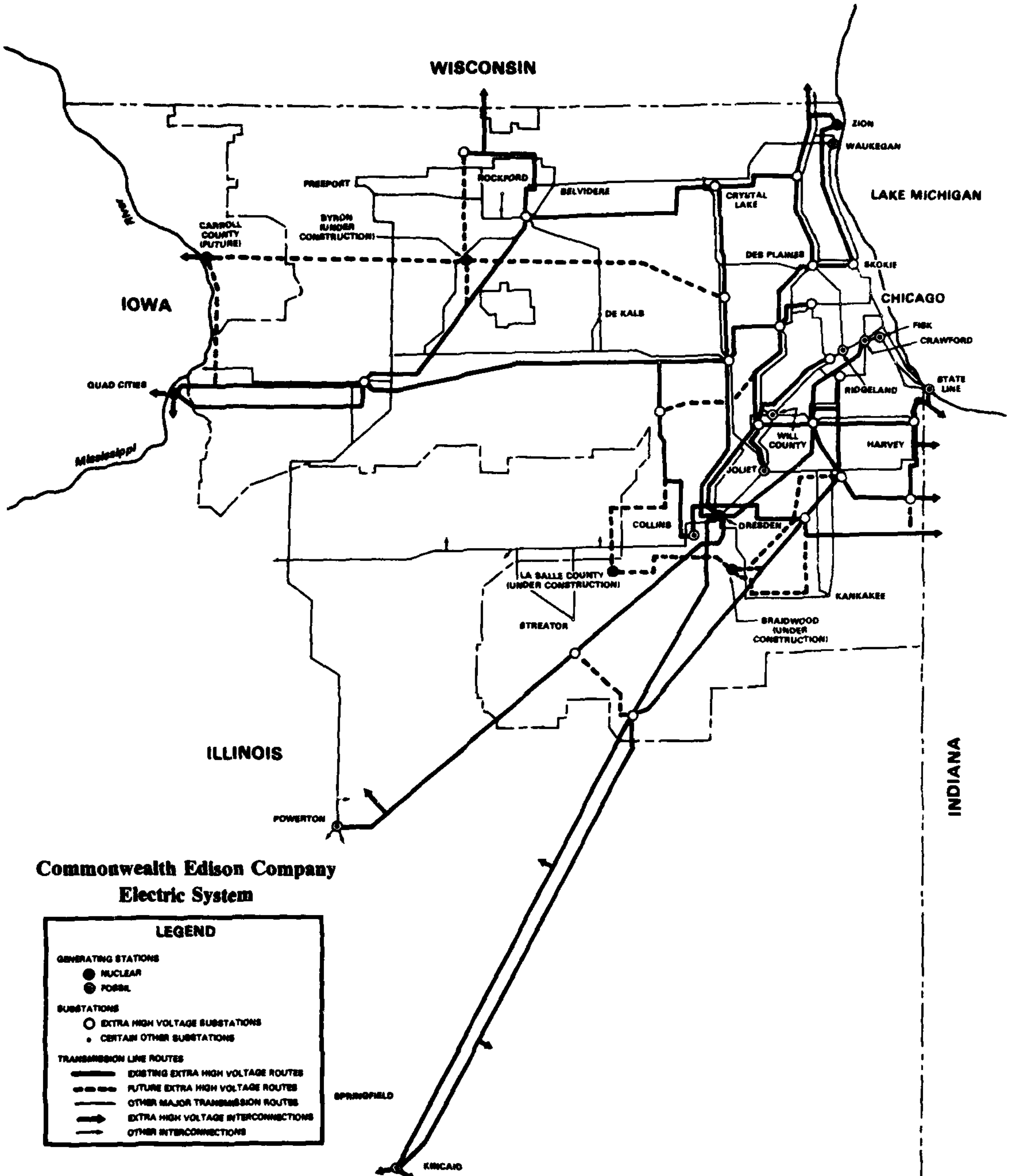
In 1980 the two Zion units' net generating capability--2,080 megawatts--represented about 12.3 percent of Commonwealth Edison's summer generating capability. However, because they are used as baseload units, 1/ they accounted for almost 19 percent of the electricity generated by Commonwealth Edison during the year.

OVERVIEW OF COMMONWEALTH EDISON COMPANY

Commonwealth Edison is an investor-owned utility company primarily engaged in the production, purchase, transmission, distribution, and sale of electricity. It is one of the largest electric utilities in the country, with a total gross utility plant of $12 billion, including construction work in progress of $4.1 billion. Headquartered in Chicago, Commonwealth Edison's electric service territory (see p. 2) covers about 11,525 square miles of northern Illinois, with an estimated population of 8 million. In 1980, the utility sold 62.2 billion kilowatt hours (kWh) of electricity to its 2.9 million customers and collected $3.3 billion in revenues.

The highest level of electric demand by Commonwealth Edison's customers occurs in the summer. The company, therefore, plans its generating capability toward meeting the summer peaks.

1/Baseload units run at full capacity as much as possible to meet minimum customer demand.



Commonwealth Edison Company Electric System

The summer generating capability in 1981 will be 16,864 megawatts, consisting of the following generating sources:

Generating sources	Megawatts
Nuclear	a/ 4,778
Steam-fossil fuel	10,185
Peaking units	1,277
Pumped storage	624
Total	16,864

a/Includes Zion, Quad-Cities and Dresden facilities.

Nuclear plants under construction will substantially increase the company's generating capability. From 1982 through 1986, six nuclear units costing $7.1 billion are scheduled to begin service, adding 6,516 megawatts and bringing total summer capability in 1987 to 23,265 megawatts from the following sources:

Generating sources	Megawatts
Nuclear	a/11,491
Steam-fossil fuel	10,185
Peaking units	1,277
Pumped storage	312
Total	23,265

a/Includes 197 megawatts from an old nuclear unit now out of service but expected to be returned to service in 1986.

Included above are the plant and equipment of the Commonwealth Edison Company of Indiana, a wholly owned subsidiary that operates a single coal-fired plant. Commonwealth Edison purchases the entire output of the Indiana subsidiary. In this report, the subsidiary plant is considered part of the parent's generating capacity and its output is considered part of the parent plant's electric generation, rather than purchased power. Commonwealth Edison also owns a uranium mining and milling operation, as well as a subsidiary which controls coal and uranium ore rights for future development.

INTERCONNECTIONS WITH OTHER UTILITIES

Commonwealth Edison is a member of the Mid-America Interpool Network (MAIN), one of the nine regional councils of the National Electric Reliability Council, whose purpose is to augment the reliability and adequacy of the bulk power supply of the electric utility systems in North America. MAIN promotes coordination of planning, construction, and utilization of generation and transmission facilities of its members in order to improve the reliability of electric bulk power supply in the Midwest. MAIN's membership includes electric power systems in upper Michigan,

Wisconsin, Illinois, and Missouri. Commonwealth Edison is the largest member, accounting for about 40 percent of MAIN's 41,648-megawatt capability.

Commonwealth Edison's transmission ties with neighboring utilities in MAIN, as well as utilities to the east and west, provide the utility with substantial transfer capability. Electric energy is interchanged with other utilities to maintain reliable electric service or to obtain electricity at prices below the company's own production cost at the time of the purchase. In 1980, Commonwealth Edison's net purchases were 4,184,563 megawatt hours of electricity.

OBJECTIVE, SCOPE, AND METHODOLOGY

Our requestors asked us to address the following issues:

--The current costs of operating and maintaining the nuclear units at Zion.

--The estimated costs of complying with new and possible future Nuclear Regulatory Commission (NRC) safety requirements.

--The estimated cost of closing the units down and its effects on the consumers and companies.

--The role of Government agencies in mitigating potentially adverse effects of closing the plant.

We evaluated the feasibility of options that could be implemented to deal with capacity deficiencies resulting from closing Zion. The cost of replacing Zion with purchased power was determined in the production cost analyses. Costs of replacement facilities are included in the revenue requirement estimates. We did not examine the cost impact of other options, such as operating with reduced reserves or programs to reduce electricity demand.

We held numerous discussions with cognizant Federal, State, and local officials, and obtained and analyzed documents, studies, reports, and related data.

We limited our work to the development and analyses of the comparative costs of continuing to operate the Zion units or to close them down in 1981. As such, we did not address the issue of the units' inherent operational safety or the question of nuclear plant siting.

The general nature of the subcommittee request required extensive assessments of the most likely future conditions and costs. As a result, it was necessary to model the probable operations of the Commonwealth Edison system under various

scenarios, including a situation where no nuclear power would be available from the Zion units. The scenarios included assumptions concerning electric demand growth, future construction, availability of purchased power, and future fuel costs. To simulate the production cost effects, Commonwealth Edison used a computerized production costing program to run our scenarios for the years 1981-2000. The methodology and assumptions used to project production costs are described in chapter 3 and appendix II.

The effects on revenue requirements were estimated from the production cost projections and Commonwealth Edison revenue requirement projections for 1981 and the first 6 months of 1982. Using our methodology, these projections were extrapolated through 1986. We prepared revenue requirement estimates under alternate assumptions for load growth and regulatory treatment. We also analyzed revenue requirements through the year 2000, though in lesser detail. The methodology and assumptions used for determining revenue requirements are discussed in chapter 3. We assessed the results for reasonableness through analysis of data and discussions with Commonwealth Edison personnel and utility engineering and financing experts. Federal Energy Regulatory Commission (FERC) engineers assisted us in analyzing the impact the loss of Zion would have on the reliability of electric service and the impact on power transmission within and around the Commonwealth Edison service area.

OUR RELATED WORK

In November 1980, we issued a report on the economic impact of closing the Indian Point nuclear facility located 30 miles north of New York City and jointly owned by the Consolidated Edison Company of New York and the Power Authority of the State of New York. 1/ Our analysis disclosed that:

--Indian Point nuclear power is generated at about one-fourth the cost of that generated by comparable oil-fired units in the Con-Edison system.

--The Indian Point units provide nearly one-third of the electric energy needed for Con-Edison's franchise area customers, but currently available non-nuclear generating capacity is sufficient to meet normal demands on the system.

--Continued reliability of service without Indian Point will depend on the successful completion of planned generating facilities and transmission line improvements.

1/"Economic Impact of Closing the Indian Point Nuclear Facility," EMD-81-3, Nov. 7, 1980.

--The loss of Indian Point could increase residual oil consumption in New York by about 20 million barrels the first year, with declining amounts thereafter.

--Use of expensive low-sulphur oil to generate replacement energy could cost Con-Edison and Power Authority of New York customers over $600 million during the first year.

--Incremental revenue requirements for Con-Edison to cover all costs resulting from closing Indian Point could amount to over $18 billion during the next 15 years and as much as $600 million annually for the Power Authority of New York.

--Few, if any, options are available to reduce oil consumption and costs that are not already being undertaken by the utility companies and included in revenue requirement forecasts.

Also, our report, "Three Mile Island: The Financial Fallout" (EMD-80-89, July 7, 1980), addressed the financial effects on the owner utility caused by a forced closure of a nuclear facility. We concluded that the closure of the two nuclear units at Three Mile Island has had a significant adverse impact on the utilities' ability to raise capital, pay dividends, and contain power costs to consumers.

Our report "Areas Around Nuclear Facilities Should Be Better Prepared for Radiological Emergencies" (EMD-78-110, March 30, 1979) stated that most nuclear facilities seemed prepared to respond to nuclear releases within their boundaries, but it is questionable whether the public beyond plant boundaries would be adequately protected. We made recommendations to cognizant agencies to increase their preparedness for a nuclear accident and to condition new plant licensing on having State-approved emergency plans. The agencies have responded to our recommendations and have either taken or are taking the necessary implementing actions.

CHAPTER 2

NUCLEAR POWER ELECTRIC COSTS

ARE RELATIVELY LOW AND

CONTRIBUTE TO COMPETITIVE RATES

In 1980, Commonwealth Edison generated over 63 billion kWh of electricity from its powerplants. Of this amount, about 12 billion kWh, or almost 19 percent, came from the two Zion nuclear units. The cost of electric service charged to customers from the Zion station was 3.3 cents per kWh compared to 5.0 cents per kWh for energy produced from coal units, 12.3 cents per kWh for steam-oil units, and 19.8 cents per kWh for peaking units.

Service costs are the direct production expense for electric power generation (e.g., fuel, operation, and maintenance) plus costs incurred by the utility independent of the units of electricity produced by the powerplants (e.g., depreciation, transmission, distribution, administration, interest, taxes, and return on investment). Although the Zion plant itself is more expensive than most of the company's fossil-fired units and commands a large share of the indirect costs, its direct production costs were far lower than units fueled by coal and oil.

Increased costs for the Zion plant will result from safety-related and other modifications. Additional safety requirements imposed by NRC could add to these costs. Costs for emergency preparedness will also be incurred, but these will not have a significant effect on the company's rates or financing.

Commonwealth Edison customer costs are about average when compared with neighboring companies and utilities across the country. The Zion units have contributed to keeping the company's costs in line.

TOTAL SERVICE COSTS OF ZION UNITS LOWER THAN FOSSIL-FUEL UNITS

Like Commonwealth Edison's two other nuclear plants, the Zion station produces electricity at lower costs than the company's fossil-fired units. Zion's indirect costs per kWh are about the same as those of coal-fired units, but fuel costs are substantially less. Table 1 shows the 1980 direct production expense and other indirect costs per kWh for Commonwealth Edison's different unit types.

Table 1

Electric Service Costs by Type of Generating Unit

Type of unit	Direct production expense	Depreciation expense	Other indirect cost	Total service cost
	(cents per kWh)			
Zion	0.695	0.209	2.393	3.297
Other nuclear	0.820	0.141	1.715	2.676
Coal	2.472	0.173	2.410	5.055
Steam-oil	6.432	0.435	5.436	12.303
Peakers-oil and gas	8.973	1.670	9.125	19.768

A unit cost comparison can be somewhat misleading because the wide cost disparity in fuel costs results in the nuclear units being run more than the fossil units. This allows the depreciation and indirect costs of the nuclear units to be spread over a much larger kWh base than the other less-utilized units, thereby reducing the total per kWh cost. Estimated per unit costs of running coal-fired units at higher levels, however, are still greater than for nuclear units.

Zion direct production costs lowest of Commonwealth Edison's units

Direct costs for electric power generation are a composite of fuel and other expenses for operation and maintenance. Commonwealth Edison collected about $3.3 billion for electric service in 1980, of which over $1.4 billion was attributed to direct production costs.

Table 2 shows the 1980 direct production costs for the Zion nuclear station both in total dollars and on a per kWh basis.

Table 2

Direct Production Cost Data for Zion Units--1980

Type of cost	Total cost	Cost per kWh
		(cents)
Fuel	$44,260,515	0.375
Operations	19,049,049	.162
Maintenance	18,606,491	.158
Total	$81,916,055	.695

The nuclear fuel used in reactors is amortized to fuel expense based on the quantity of heat produced for the generation of electricity. A provision for future spent fuel disposal costs is included in nuclear fuel expense. Currently, these costs are allowed at the rate of 0.1 cent per kWh of electricity generated. Commonwealth Edison has requested that this rate be increased to 0.2 cent per kWh.

The Zion nuclear station's direct production cost per kWh is lower than any of Commonwealth Edison's other generating units. Cost comparisons between the Zion station and the company's other nuclear and fossil-fired plants are shown below.

Table 3

Direct Production Cost Comparison by Type of Generating Units--1980

	Generating unit				
Type of cost	Zion	Other nuclear	Coal	Steam-oil	Peaking-oil
	(cents per kWh)				
Fuel	0.375	0.346	2.084	6.116	7.827
Operations	.162	.262	.151	.149	.181
Maintenance	.158	.212	.237	.167	.965
Total	.695	.820	2.472	6.432	8.973

Higher Zion plant and indirect costs offset by low kWh costs

Production costs alone do not fully represent the costs to provide electricity. Other costs incurred by utilities must also be considered. The major cost items for Commonwealth Edison are depreciation, taxes, interest, general administration, return on investment, and transmission and distribution expenses.

Depreciation expense is directly related [illegible] the capitalized cost of each generating plant. The Zion stati[illegible]s cost per kilowatt of summer capability is one of the hi[illegible]st of Commonwealth Edison's plants now in service. Table 4 shows the cost per kilowatt of summer capability for Zion and other large Commonwealth Edison plants.

Table 4

Summer Capability and Costs for Larger Commonwealth Edison Plants

Plant	Year last unit installed	Summer capability	Cost per kilowatt
		(kilowatts)	
Powerton (coal)	1975	1,400,000	$ 339
Zion (nuclear)	1974	2,080,000	301
Collins (oil)	1979	2,698,000	254
Will County (coal)	1963	1,010,000	236
Joliet (coal)	1966	1,315,000	205
Kincaid (coal)	1968	1,108,000	191
Quad-Cities (nuclear)	1972	a/1,153,500	178
Dresden (nuclear)	1971	b/1,545,000	174

a/Commonwealth Edison's three-fourths share.

b/Excludes Dresden 1's 197,000-kilowatt summer capacity because the unit is out of service.

Commonwealth Edison recovers these plant costs through depreciation provisions that allocate the costs over the useful lives of the plants. For nuclear plants, the annual rate is currently 4 percent of the depreciable plant and equipment, while fossil-fired plants are allowed 3.6 percent. Table 5 shows the 1980 depreciation expense for Zion and other types of generating units.

Table 5

Depreciation Expense by Type of Generating Unit--1980

Type of unit	Total costs	Cost per kWh
	(millions)	(cents)
Zion	$ 24.7	0.209
Other nuclear	20.0	0.141
Coal	52.1	0.173
Steam-oil	29.2	0.435
Peakers-oil and gas	7.7	1.670
Total	$133.7	

The nuclear depreciation expense includes additional charges unique to nuclear units. These are costs for interim chemical cleaning and end-of-life decommissioning. For the Zion station, $2.6 million and $4.1 million, respectively, were included in its 1980 depreciation expense for these two items.

To develop a complete cost of providing electricity, we allocated Commonwealth Edison's other indirect costs to the various types of generating units. 1/ Table 6 shows these costs that, when added to the direct production costs and depreciation expenses, result in the company's cost of electric service charged to customers (table 1, page 8).

Table 6

Other Indirect Costs by Type of Generating Unit--1980

Type of unit	Total cost	Cost per kWh
	(millions)	(cents)
Zion	$ 282.0	2.393
Other nuclear	243.3	1.715
Coal	726.5	2.410
Steam-oil	364.7	5.436
Peaker-oil and gas	42.0	9.125
Total	$1,658.5	

As previously stated, unit cost comparisons can be somewhat misleading if the units are not used to the same extent. The extent to which each type of unit is used depends on its respective production (fuel) costs. Thus, the nuclear units are used most, followed by coal-fired units, oil-burning steam units, and finally, peaking units. Fuel costs vary proportionately with plant output, while operating, maintenance, depreciation, and other indirect expenses tend to remain constant over a range of output. The lower usage of coal, steam-oil, and peaking units increases the cost per kWh relative to the nuclear plants. Because of the large difference in fuel costs, however, total costs per kWh generated at Zion would still be less than the costs of fossil-fueled generation, even if the fossil units were used to the same extent as Zion.

CONTINUED OPERATION OF THE ZION UNITS WILL RESULT IN ADDITIONAL COSTS

The continued use of the Zion units will require future additional expenditures. Commonwealth Edison plans to spend $137.6 million over the next 5 years for additions to the plant. Radiological emergency response plans for the Zion plant are expected to cost Commonwealth Edison about $7 million over the next 5 years, with relatively minor additional costs being borne

1/No costs were allocated for purchased power.

by Federal, State, and local governments. Additional expenditures, uncertain at this time but possibly large, may also be required by NRC resulting from its review of nuclear stations near densely populated areas.

Future plant additions

For the years 1981 through 1985, Commonwealth Edison plans to spend $137.6 million for additions to the Zion plant, about half of which are safety-related modifications resulting from the Three Mile Island accident. As projects are completed, the costs are added to plant in service and to the rate base on which the company earns a return on investment. The costs of the additions are recovered through depreciation expense.

Nuclear plants are subject to modifications and improvements mandated by NRC or undertaken voluntarily by the licensees to improve safety. Commonwealth Edison's current 5-year budget for Zion includes an estimated $69.4 million for short- and long-term modifications resulting from the Three Mile Island accident. Total costs, including money already spent and money to be spent beyond the 5-year budget period, are estimated at $85.7 million. These costs cover modifications for

--relief and safety valves,

--vessel instrumentation,

--plant shielding modifications,

--post-accident sampling system,

--onsite technical support center,

--control room design,

--modifications to prevent or mitigate degraded core conditions,

--relief valve line modifications,

--instruction, and

--modifications which result from reliability studies.

Other Zion modifications totaling over $62 million as authorized in the 5-year budget, and resulting from either NRC requirements or improvements in plant design, include

--security system,

--fire protection,

--new spent-fuel racks,

--new piping restraints for asymmetric vessel loads,

--new piping restraints which result from review of piping systems,

--radioactive waste system modifications, and

--new rotors.

Radiological emergency response planning

Commonwealth Edison has budgeted $6.9 million for emergency preparedness at the Zion station during the next 5 years. Most of these costs are included in the budgeted plant additions. In 1979 and 1980, the utility spent $732,000 for this purpose. Most of these costs are a result of additional emergency planning requirements developed by NRC and the Federal Emergency Management Agency (FEMA) after the Three Mile Island accident. The budgeted expenditures for emergency preparedness at Zion over the next 5 years are shown below.

Zion Emergency Response
Planning Budgeted for 1981-85

Planning activites	$2,719,000
Communications	2,186,000
Monitoring (meteorological and radiological)	19,000
Emergency operations facility	2,000,000
Total	$6,924,000

Federal, State, and local government agencies are also involved in the radiological emergency planning process. At the Federal level, NRC reviews the licensee's emergency plans for the reactor site and assures itself that the proper elements are in place. FEMA reviews and approves State and local planning and preparedness around the plant. Based on the above reviews, NRC determines whether the nuclear plant's overall preparedness is adequate for receiving or retaining an operating license. In the event of an emergency, NRC would respond to problems at the nuclear plant site. FEMA would coordinate all Federal activities offsite, including assistance to State and local government organizations. Other Federal agencies involved to some extent in nuclear emergencies are the Department of Energy, Department of Agriculture, Environmental Protection Agency, Federal Highway Administration, and Department of Health and Human Services. The planning activities of the Federal agencies are not site specific, but are category specific. Consequently, the addition or deletion of one or more nuclear units has little or no impact on their overall agency costs.

Under the overall command of the Governor, two Illinois State agencies have primary responsibility for emergency planning and response. The Department of Nuclear Safety has the technical responsibilities for radiological assessment and control. Public utilities operating nuclear facilities are assessed fees to fund the Department's Nuclear Preparedness Programs. Such fees consist of a one-time charge of $350,000 per station and annual taxes of $75,000 per reactor. These fees for Zion are included in Commonwealth Edison's budgeted amounts. The Emergency Services and Disaster Agency is the State's lead planning agency and coordinates operational es response in an emergency. The Director estimated the agency's cost per nuclear plant at $250,000 to prepare the initial plan and $40,000 to $80,000 for annual maintenance of the plan. These activities are funded by the State; however, Commonwealth Edison has defrayed some of the State costs to develop the plan for Zion (travel costs and office space, for example) and provided staffing support. Additionally, Commonwealth Edison had paid the equipment costs 1/ associated with Zion's emergency plan.

Illinois' local governments and other State agencies, such as the State police, also have emergency response roles. Because Zion's emergency planning zone extends into Wisconsin, State and local governments there also have emergency planning functions. Costs for these agencies will generally be limited to staff time and travel costs for the initial emergency planning and annual plant exercises. No staff in any agency are dedicated solely to Zion emergency planning.

Radiological emergency plans can serve a dual purpose for the State and local entities. On one hand, the plans provide a response to accidents at nuclear powerplants, while on the other, they identify evacuation routes, communications networks, and shelter arrangements for use in other emergencies. This was demonstrated recently in western Wisconsin where the State emergency response plan was effectively used to aid flood victims.

At the time of our fieldwork, the Illinois emergency plan for Zion was still being developed, and NRC was reviewing the onsite plan. The test exercise of onsite and offsite emergency response capability was scheduled for July 1981, 2/ after which NRC (with input from FEMA) will determine the adequacy of overall emergency preparedness. Because the emergency plans had

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1/The Illinois Department of Nuclear Safety has tentative plans for a remote monitoring system at each nuclear plant. The system for Zion would cost an estimated $2 million to install and $150,000 annually to maintain. These costs would be paid out of the Illinois fund financed by the fees assessed utilities on their nuclear units.

2/The test exercise was held July 29, 1981.

not been completed and approved, resources required and cost estimates were necessarily tentative. Other than the fees assessed public utilities operating nuclear facilities that fund the Department of Nuclear Safety, responsibility for the costs of offsite emergency planning is not prescribed by laws or regulation. Instead, these costs are being negotiated by Commonwealth Edison and the State and local governments. The annual exercise is expected to be the major recurring cost for State and local governments. As of September 30, 1981, these costs had not been determined.

We believe that although actions are being taken and progress is being made, too many uncertainties remain at this time to assess either the total costs of emergency planning or its practical implementation. From currently available information, however, it does not appear that the costs incurred for emergency planning will materially affect the financial health of Commonwealth Edison or customer rates.

Chemical cleaning costs

Commonwealth Edison plans three chemical cleanings for radioactive decontamination over the life of the Zion plant. The company estimates it will cost, in 1980 dollars, $14.9 million for chemical cleaning facilities installed in 1988 and $16 million each for chemical cleanings in 1988, 1995, and 2002. As indicated previously, these costs are currently being collected as part of the depreciation expense.

Additional safety measures are being studied

NRC is reviewing whether additional modifications are needed to further improve the safety factor for nuclear plants located near large population centers. Some of the design changes being considered are a filtered vented containment, core retention devices, and hydrogen control. From May 7 to June 18, 1980, NRC staff met with officials from Commonwealth Edison, Consolidated Edison, and Power Authority of the State of New York in a series of six technology exchange meetings to discuss the potential consequences of core degradation and core melt accidents and associated phenomenology for the Zion and Indian Point units. 1/

The NRC/utility company meetings were preceded by an NRC-sponsored study of nuclear accident mitigation at the Zion and Indian Point plants conducted jointly by Sandia National Laboratory, Los Alamos Scientific Laboratory, and Batelle Columbus Laboratories. The object of the study was to identify

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1/The Indian Point units are located near New York City and are owned by Consolidated Edison Company of New York and the Power Authority of the State of New York.

methods for significantly reducing the likelihood of large airborne releases of radioactivity resulting from core melt accidents where the containment ruptures above ground level.

As of September 30, 1981, NRC had not decided which, if any, design modifications might be required at Zion and no cost estimates for making the modifications had been prepared. Commonwealth Edison conducted a comprehensive probability risk assessment study to determine the risks involved and the resultant risk reduction, if any, from various plant modifications for Zion. The study was submitted to NRC on September 17, 1981, after our audit work was completed. It is currently being reviewed by NRC staff.

COMMONWEALTH EDISON CUSTOMER COSTS ARE ABOUT AVERAGE

Commonwealth Edison customers currently pay electric costs per kWh of consumption that are about average when compared with rates paid by other utility customers. The Zion nuclear units have helped keep the company's costs in line with other companies' costs.

Comparison of kWh costs of selected utilities

A comparison of average kWh costs for Commonwealth Edison with neighboring utility companies and utilities across the country is shown in table 7.

Table 7

Average Cost per kWh for the 12 Months Ending December 31, 1980

	Residential customers	All customers
	---(cents per kWh)----	
Consolidated Edison Co. of New York	11.82	10.01
Public Service Electric and Gas Co. (New Jersey)	8.42	6.90
Boston Edison Co. (Mass.)	8.05	6.93
Commonwealth Edison Co.	6.26	5.31
Southern California Edison Co.	6.23	6.06
Arizona Public Service Co.	6.23	5.10
Central Illinois Light Co.	6.04	5.10
Central Illinois Public Service Co.	5.79	4.65
Illinois Power Company	4.97	3.89
Arkansas Power and Light Co.	4.75	3.73
Georgia Power Co.	4.56	3.93

Source: Federal Energy Regulatory Commission.

Zion's contribution to Commonwealth Edison rates

The lower operating cost and high utilization of the Zion station is a contributing factor in Commonwealth Edison's average costs. As shown earlier, the 1980 total electric service cost for Zion was 3.3 cents per kWh, while coal and steam-oil units cost 5.0 and 12.3 cents per kWh, respectively. Also, during 1980, the Zion plant contributed almost 19 percent of the 63 billion kWh of electricity generated by Commonwealth Edison. The Zion nuclear units, with a 65-percent annual capacity factor, were the most used of any Commonwealth Edison unit. This combination of high use and low production (fuel) costs helped reduce the utility's overall expenses used for rate determination.

CHAPTER 3

COSTS INCREASE WITH ZION OUT OF SERVICE

Because of its large capacity and low operating costs, Zion generates more electricity than any Commonwealth Edison station. Removing Zion from service would require Commonwealth Edison to generate more electricity at its fossil-fired plants and to substantially increase power purchases. Replacing Zion's low-cost generation with these other sources would increase production costs by over $300 million in 1981. From 1981 through 1986, annual production cost increases would range from $208 to $335 million, depending on the year and the load growth assumption.

Changes in revenue requirements reflect the full financial impact of closing Zion. In addition to production costs, the changes take into account other operating costs, depreciation, taxes, and return on investment. We estimate that without Zion, annual revenue requirement increases for 1981 through 1986 would be as high as $356 million, or as low as $47.4 million, depending on the year, the annual load growth, and the costs utility regulators allow Commonwealth Edison to recover. Average costs per kWh would increase by between 1.7 and 9 percent. Not included in these estimates are the incremental decommissioning and spent fuel disposal costs which would have to be paid on an accelerated basis with Zion out of service.

Long-term revenue requirements reflect increased costs from constructing replacement capacity with Zion shut down. These costs are not significant over the 1981-86 period. Total revenue requirements for 1981 to 2000 are projected at $18.2 billion, assuming a 3-percent annual load growth and $16.6 billion, using a 1.5-percent growth rate. Because of the costs of new construction and escalation of costs to account for inflation, the revenue requirement increases are greatest during the 1990s.

Closing Zion would have other financial effects, including losses related to nuclear fuel commitments, accelerated spending on transmission projects, and losses to the local community.

With Zion limited to 70 percent of its maximum power, changes in generating mix, increased production costs, and increased revenue requirements would occur to a lesser degree.

THE LOSS OF ZION WOULD CHANGE THE UTILITY'S ELECTRIC GENERATING MIX

The actual operation of any one generating unit depends mainly on the system load, the unit's availability, and the unit's operating cost. The system load varies because of fluctuations in electric demand both during the day and on a

seasonal basis. However, a unit is not always available for service because of scheduled maintenance and unscheduled outages. Scheduled maintenance for nuclear units, such as Zion 1 and 2, includes a 7-week refueling operation about once a year. Subject to availability, units are put into service in the order of their operating costs. Those units with the least operating costs are put into service first, followed by the next cheapest units, and so on until the demand at a particular time is met. Electricity available for purchase from other utilities is also considered in accordance with its price.

Commonwealth Edison's nuclear units are the first units used to meet the load because of their low operating costs. They are run to the maximum extent possible to meet the minimum continuous demand year around. Next into service are the coal-fired units, followed by the more expensive oil-fired units. This ordering of plant usage is reflected in capacity factors (ratios of electricity generated to the maximum that could have been generated) shown in table 8.

Table 8

Generating Characteristics of Commonwealth Edison Units During 1980

Type of unit	Net generation	Capacity factor (note a)
	(megawatt hours)	(percent)
Nuclear	25,969,896	60.8
Coal	30,149,518	49.6
Steam-oil	6,708,434	23.6
Peakers-oil and gas	460,867	4.1
Total generated	b/63,303,298	
Purchased power (net)	4,184,563	

a/Based on summer capabilities.

b/Includes 14,583 megawatt hours generated at a hydroelectric plant.

Zion generated 11,786,243 megawatt hours in 1980 for a capacity factor of 64.7 percent, the highest of any Commonwealth Edison station. From 1977 through 1980 the Zion station's average capacity factor was 64.3 percent.

Method used to analyze production cost changes

To assess the change that would probably result without the Zion station, Commonwealth Edison modeled the operations of its system with and without Zion using Energy Management Associates, Incorporated's PROMOD III, a computerized production cost and reliability model for electric utilities. The program determines which generating units would be used to meet weekly loads, taking into account the order in which units are to be committed, scheduled maintenance, probability of forced outages, and other factors. At our request, Commonwealth Edison ran the model to project production costs with Zion in service and out of service using alternative annual load growth assumptions of 3 percent and 1.5 percent.

Load growth projections

The rate of electric load growth affects the generating capacity that will be needed, as well as the amount of electricity to be generated. Table 9 shows peak load and sales during the last 10 years.

Table 9

Peak Load and Sales, 1971-80

	Peak load		Sales	
Year	Megawatts	Percent increase (decrease) from prior year	Megawatt hours	Percent increase (decrease) from prior year
1971	10,943	9.1	48,765,000	4.1
1972	11,750	7.4	52,330,000	7.3
1973	12,462	6.1	57,100,000	9.1
1974	12,270	(1.5)	56,266,000	(1.5)
1975	12,305	0.3	56,696,000	0.8
1976	12,907	4.9	58,337,000	2.9
1977	13,932	7.9	61,449,000	5.3
1978	13,720	(1.5)	64,041,000	4.2
1979	13,804	0.6	64,058,000	-
1980	14,228	3.1	62,221,000	(2.9)

Source: Commonwealth Edison Company.

The above growth rates generally follow the national trend. Prior to 1974, nationwide demand grew at an average of 7 percent a year. In years thereafter, growth occurred at a slower rate. Commonwealth Edison correspondingly reduced its pre-1974 annual growth projection of about 7 percent down in steps to the current 3-percent projection made at the end of 1980.

Historical growth rates vary depending on what years are used. Between 1971 and 1980, peak load grew at an average annual rate of 3 percent and sales at 2.7 percent. Between 1975 and 1980, peak load grew at 2.9-percent annually and sales at 1.9 percent. Company officials attribute relatively low sales in 1979 and 1980 to reduced economic activity and to weather conditions.

Commonwealth Edison's projections rely on econometric models that use historical data. The projections are adjusted for other factors where there are insufficient historical data, including customer responses to pricing policies such as time-of-day rates, Government policies, and the impact of more efficient energy use.

Because load growth forecasts inherently are subject to uncertainties, we analyzed the production impact of closing Zion using both the company's 3-percent growth projection and growth at 1.5 percent annually. As noted above, growth rate projections have been trending down, although we do not know if this downward trend will continue. However, the 1.5-percent growth rate analyses provide some indication of the effects on company operations, should growth rates not be as high as now projected.

The computer model and the assumptions used in the production cost model are discussed in appendix II.

Electric generation and power purchases vary without Zion

With the Zion units in service, Commonwealth Edison's future basic generation generally follows the mix in 1980 as noted in table 8, except that nuclear generation takes on a larger share as new nuclear units come into service. Zion's generation from 1977 to 1980 averaged 11.7 billion kWh, the maximum occurring in 1978 at 13.5 billion kWh. For 1981 through 1986, the Zion units' generation is projected to average 11.6 billion under the 3-percent load growth assumption and 11.3 billion assuming 1.5-percent growth. No constant capacity factor is assumed for the Zion station; rather, the capacity factor peaks at 69 percent in 1982 and declines thereafter to 59 percent in 1986 (55 percent using 1.5-percent load growth) as the new nuclear units take up some of the load. The production model did not provide for the possible sale to other utilities of Zion capacity or generation not needed by Commonwealth Edison.

The loss of the Zion units would place a larger load on Commonwealth Edison's fossil-fueled units, but most of Zion's lost generation would be expected to be made up with purchased power. Tables 10 and 11 show the source and quantity of energy for the Commonwealth Edison system with and without Zion under the 3-percent annual load growth assumption for 1981 through 1986. Tables 12 and 13 show the comparable data, using 1.5-percent annual load growth. Total energy generated and purchased exceeds the amount sold because of company use of electricity, transmission and distribution losses, and losses from generating electricity through pumped storage.

Table 10

Projected Electric Generation
and Purchases--Zion in Service

(3-Percent Annual Load Growth)

Source of generation	1981	1982	1983	1984	1985	1986
	Megawatt hours					
	(000 omitted)					
Nuclear	26,763	31,382	38,955	44,478	49,503	55,226
Coal	30,101	29,391	26,491	24,815	22,418	21,780
Steam-oil	6,709	5,957	5,982	5,959	5,934	2,957
Peakers-oil and gas	513	175	145	100	84	108
Total generated	64,086	66,905	71,573	75,352	77,939	80,071
Purchases	4,898	4,388	1,822	231	131	717
Total available	68,984	71,293	73,395	75,583	78,070	80,788

Source: Commonwealth Edison Company.

Table 11

Projected Electric Generation
and Purchases--Zion out of Service

3-Percent Annual Load Growth)

Source of generation	1981	1982	1983	1984	1985	1986
	Megawatt hours					
	(000 omitted)					
Nuclear	14,713	18,772	27,222	33,453	39,167	45,300
Coal	32,030	31,417	29,150	28,630	27,077	26,600
Steam-oil	7,696	5,893	5,881	5,950	5,899	4,147
Peakers-oil and gas	1,193	84	71	83	114	240
Total generated	55,632	56,166	62,324	68,116	72,257	76,287
Purchases	13,430	15,165	11,103	7,466	5,829	4,499
Total available	69,062	71,331	73,427	75,582	78,086	80,786

Source: Commonwealth Edison Company.

Table 12

Projected Electric Generation
and Purchases--Zion in Service

(1.5-Percent Annual Load Growth)

Source of generation	1981	1982	1983	1984	1985	1986
	Megawatt hours					
	(000 omitted)					
Nuclear	26,763	31,373	38,815	44,064	48,777	53,730
Coal	30,053	29,365	24,994	21,364	18,140	18,103
Steam-oil	6,559	5,959	5,949	5,922	5,878	2,286
Peakers-oil and gas	485	137	95	41	25	27
Total generated	63,860	66,834	69,853	71,391	72,820	74,146
Purchases	4,855	2,373	607	56	34	332
Total available	68,715	69,207	70,460	71,447	72,854	74,478

Source: Commonwealth Edison Company.

Table 13

Projected Electric Generation
and Purchases--Zion out of Service

(1.5-Percent Annual Load Growth)

Source of generation	1981	1982	1983	1984	1985	1986
	Megawatt hours					
	(000 omitted)					
Nuclear	14,713	18,772	27,213	33,371	38,991	44,855
Coal	32,014	31,365	28,246	27,507	26,711	25,071
Steam-oil	7,575	5,888	5,909	5,936	5,921	3,369
Peakers-oil and gas	1,134	83	85	108	109	138
Total generated	55,436	56,108	61,453	66,922	71,732	73,433
Purchases	13,357	13,145	9,035	4,507	1,117	983
Total available	68,793	69,253	70,488	71,429	72,849	74,416

Source: Commonwealth Edison Company.

Fossil fuel consumption would increase without Zion

The changed generating mix resulting from the closing of Zion would increase Commonwealth Edison's use of coal. The impact on oil and gas use varies, but overall, consumption of these fuels would increase. In addition, the increased purchased power would result in increased fuel use--presumably coal and oil--on the part of other utilities selling the power. Tables 14 and 15 show the direct effect on fossil fuel use without Zion under the two growth rate assumptions.

Table 14

Increased (Decreased) Fossil Fuel Use--Zion out of Service

(3-Percent Annual Load Growth)

Year	Coal (tons)	Number 6 oil (barrels)	gas (therms)	Number 2 oil (gallons)
	---------------	-------(000 omitted)	-------	---------------
1981	977	1,439	73,924	25,737
1982	955	(178)	(9,294)	(3,946)
1983	1,350	(119)	(1,190)	(7,969)
1984	1,988	(56)	-	(2,022)
1985	2,491	19	-	3,632
1986	2,594	2,234	-	15,672

Source: Commonwealth Edison Company.

Table 15

Increased (Decreased) Fossil Fuel Use--Zion out of Service

(1.5-Percent Annual Load Growth)

Year	Coal (tons)	Number 6 oil (barrels)	Gas (therms)	Number 2 oil (gallons)
	---------------	-------(000 omitted)	-------	---------------
1981	998	1,531	70,739	24,429
1982	934	(136)	(5,091)	(2,667)
1983	1,718	(33)	(126)	(1,111)
1984	3,365	107	-	8,089
1985	4,802	143	-	10,091
1986	3,883	2,021	-	13,220

Source: Commonwealth Edison Company.

The decreases in fuel use occur because of increased firm purchases assumed in the production model. Firm purchases are included in amounts sufficient for Commonwealth Edison to maintain a 15-percent reserve margin without Zion. The capacity provided by firm purchases is then dispatched economically. When cheaper than the company's own generated electricity, purchases replace the company's fossil-fueled generation.

No use of natural gas is assumed after 1983, when current contract commitments expire.

PRODUCTION COSTS INCREASE WITHOUT ZION

As discussed in chapter 2, Commonwealth Edison's nuclear units are the company's most economical method of generating electricity. Under the 3-percent growth assumption, replacing Zion's capacity and generation with other sources would increase production costs in 1981 by $313.3 million, as shown in table 16.

Table 16

1981 Production Cost Changes--
Zion out of Service

(3-Percent Annual Load Growth)

Increased costs	
High-sulfur coal	$ 266,000
Low-sulfur coal	42,209,000
Number 6 oil	43,053,000
Gas	33,545,000
Number 2 oil	26,790,000
Purchased electricity	301,209,000
Total	447,072,000
Decreased costs:	
Nuclear fuel	96,620,000
Operation and maintenance costs	37,200,000
Total	133,820,000
Net increase	$313,252,000

The nuclear fuel savings represent the cost of fuel Zion would have used, less small increases in fuel expenses at other nuclear stations. Should Zion close, however, additional costs for losses on unused fuel would be incurred (see p. 38). Similarly, the savings from operation and maintenance are the costs that would be incurred with Zion running. However, a facility with large amounts of radioactive materials cannot be instantly closed. Maintenance and security costs would be incurred for

some years until the facility is completely decommissioned (See p. 33.)

Production cost increases for the period 1981-86 under the two annual load growth assumptions are shown in table 17 below.

Table 17

Production Cost Increases Without Zion

Year	3-percent load growth	1.5-percent load growth
	(millions)	
1981	$ 313.3	$ 312.3
1982	279.7	285.9
1983	293.8	273.8
1984	288.0	245.8
1985	267.8	208.5
1986	335.1	257.6

These production cost estimates are based on the assumption that significant amounts of additional firm purchased capacity--as much as 2,080 megawatts in the early years--will be available so that Commonwealth Edison can maintain its 15-percent reserve margin objective. To the extent firm contracts are not available, demand charges 1/ included in the above amounts would not be incurred, but more generation by Commonwealth Edison's uneconomical oil units would probably be required, as would more purchases at the expensive emergency rate. 2/

Another factor affecting the production costs is the availability of new nuclear units. In the cost projections, it is assumed that more than 1,000 megawatts will be added to Commonwealth Edison's summer capability each year from 1982 through 1987. These units mitigate the production cost effect of losing Zion by replacing purchased power that would otherwise be required with less costly nuclear generation. The service dates of these units, however, are subject to delays from a variety of design, construction, financing, and regulatory factors. If delays are experienced, the production cost increases without Zion would be higher, especially under the 3-percent annual load growth assumption. The effects on capacity needs of nuclear unit delays are discussed in chapter 4.

1/A demand charge is paid to the seller for the assurance that the power will be available when the buyer needs it.

2/Emergency power is purchased when the buyer's generating capacity is insufficient to meet demand.

REVENUE REQUIREMENT INCREASES VARY DEPENDING ON ASSUMPTIONS USED

Revenue requirements are the sum of operating expenses, depreciation expense, taxes, interest, and return on investment. The production cost increases, discussed previously, represent the most immediate cost impact of shutting down the Zion units. The loss of the units, however, would also affect the other cost elements, including

--reduction of real estate tax and insurance costs at the Zion site,

--eventual increased construction and construction financing costs,

--changes in depreciation expense and return on rate base, and

--revenue tax and income tax changes resulting from changes in other expenses.

The extent, if any, that Commonwealth Edison would be able to recover the cost of the Zion plant and earn a return on investment after the plant was closed would be determined by the Illinois Commerce Commission (ICC), the State agency that regulates utility rates. 1/ Commonwealth Edison has had no experience with premature closing of a powerplant. Similarly, ICC staff said that there has been no precedent for such an event within the State. Because of this uncertainty, we estimated revenue requirements under three possible scenarios:

--Removal of the unrecovered costs of the plant from the rate base so that no recovery of costs and no return on investment is allowed.

--Removal of Zion's costs from the rate base, but recovery of the costs allowed through a 10-year writeoff as depreciation expense.

--Inclusion of Zion's costs in the rate base so that a return on investment is allowed while the costs are recovered through a 10-year writeoff.

To estimate the financial impact of Zion's loss on Commonwealth Edison and its customers from 1981 through 1986, we used the company's revenue requirement projections for 1981 and the first half of 1982 prepared for its current rate increase

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1/FERC has jurisdiction over wholesale electric rates; however, this is a minor part of Commonwealth Edison's sales.

request. For subsequent periods, the estimates reflect completion of the company's current construction program and a 9-percent annual escalation of expense items. The rate of return on common equity--16.7 percent--is based on the recommendation of Commonwealth Edison's rate of return witness in recent rate hearings before ICC. The changes in fuel costs with Zion out of service are those projected using the production model. To account for State and local taxes on utility bills, expense items are increased by 9 percent to estimate the amount of revenue the utility must collect to recover its costs. Similarly, operating income is increased by 115 percent to account for utility revenue and income taxes used in determining revenue requirements. Revenue requirements were estimated using 3- and 1.5-percent load growth projections.

With Zion removed from service, our estimated revenue requirement increases for 1981 through 1986 range from $47 million to $356 million, depending on the year and the assumptions used. Should Zion continue to operate, additional costs would be incurred for plant additions, emergency planning, and chemical cleaning--costs that would not be incurred with Zion closed down. The effects of not incurring these costs are reflected in our calculations. Costs for decommissioning and spent fuel disposal are included in depreciation and fuel expense with Zion in service. To determine the impact of closing Zion, these costs are not included in the costs without Zion. They will, however, have to be incurred regardless of when Zion closes. To the extent these costs would be incurred during the 1981-86 period, our revenue requirement estimates would be increased.

Revenue requirements: Zion removed from the rate base and no writeoff allowed

Without Zion, revenue requirements for fuel and purchased power increase, while operation, maintenance, insurance, and real estate tax expenses decrease. With Zion also taken out of the rate base, depreciation expense is not incurred, and a return on investment is not earned. Table 18 shows the net change in revenue requirements for 1981 under the 3-percent load growth assumption.

Table 18

Net Change in 1981 Revenue Requirements--
Zion Removed from Rate Base

(3-Percent Load Growth)

Cost element	Cost increase (decrease)	Increase (decrease) in revenue requirements
	------------(millions)	-----------
Fuel and purchased power	$350.5	a/$381.0
Operation and maintenance expense	(37.2)	a/(40.4)
Real estate taxes	(11.8)	a/(12.8)
Insurance expense	(6.7)	a/(7.3)
Depreciation expense	(25.5)	a/(27.7)
Return on investment in plant	(48.2)	b/(103.6)
Net increase		$189.2

a/Expense item divided by 0.92 to provide for State and local utility taxes.

b/Return on investment divided by 0.465 to provide for utility and income taxes.

With Zion immediately and permanently removed from the rate base, the company and its stockholders would incur a one-time loss of about $590 million on the undepreciated costs of the Zion plant, construction work in progress, and fuel reduced by whatever tax effects such a loss would have. Costs to the stockholders would increase to the extent the net increased revenue requirements for production costs were not recovered through higher utility rates.

Table 19 shows 1981-86 net revenue increases with the Zion plant immediately removed from the rate base.

Table 19

Net Revenue Requirement Increases with Zion out of Service: Zion Removed From Rate Base and no Writeoff of Plant Costs Allowed

Year	3-percent load growth	1.5-percent load growth
	----------(millions)	----------
1981	$189.2	$188.1
1982	139.6	146.3
1983	147.4	125.6
1984	135.9	89.5
1985	113.5	47.4
1986	177.9	91.6

Revenue requirements: 10-year writeoff with no return on investment

If Commonwealth Edison were allowed to write off the cost of the Zion plant and fuel in its reactors as depreciation expense over a 10-year period, the revenue requirements would increase by $64.2 million annually beyond the increase with no writeoff allowed. Based on the plant and fuel costs at the end of 1980, table 20 shows the computation of these additional annual expenses.

Table 20

Annual Revenue Requirements Needed for 10-year Writeoff of Zion Plant and Fuel

	Amount
	(millions)
Plant in service (not including land)	$624.6
Construction work in progress	17.3
Plant costs already recovered through depreciation charges	(106.0)
Cost of fuel in reactors	a/108.8
Fuel costs already recovered through amortization expenses	(54.1)
Costs to be recovered over 10 years	590.4
Total revenue requirements	b/641.7
Annual revenue requirements	64.2

a/Once nuclear fuel is irradiated, it cannot be salvaged, so the value of the unused fuel is lost.

b/Costs to be recovered divided by 0.92.

The $64.2 million in annual requirements is the amount that would be required instead of the depreciation expense that would be incurred with Zion in service. In determining revenue requirements for 1981, for example, depreciation revenue requirements shown in table 18 increase by $36.5 million instead of decreasing by $27.7 million. Revenue requirement increases with the 10-year writeoff and no return on investment are shown in table 21.

Table 21

Net Revenue Requirement Increases With Zion out of Service: Zion Removed From Rate Base and 10-year Writeoff of Plant Costs

Year	3-percent load growth	1.5-percent load growth
	(millions)	
1981	$ 253.4	$ 252.3
1982	203.8	210.5
1983	211.6	189.8
1984	200.1	153.7
1985	177.7	111.6
1986	242.1	155.8

Revenue requirements: 10-year writeoff with return on investment allowed

Revenue requirements would further increase beyond those in the prior scenarios if Commonwealth Edison were allowed a return on its investment in the Zion plant and its nuclear fuel as the costs are being written off. Table 22 shows the base for return on investment.

Table 22

Base for Return on Investment Costs as of December 31, 1980

	Amount (millions)
Plant in service (including land)	$625.8
Construction work in progress	17.3
Accumulated depreciation (including provisions for decommissioning and chemical cleaning)	(145.8)
Nuclear fuel in reactors	108.8
Accumulated amortization (including provisions for spent fuel disposal)	(85.9)
Accumulated deferred income taxes	(62.9)
Base	$457.2

Revenue requirements for return on investment were calculated as shown in table 23. Net revenue requirement increases with a 10-year writeoff and return on investment are shown in table 24 (the sum of the amounts calculated in tables 21 and 23).

Table 23

Revenue Requirements for Return on Investment

	1981	1982	1983	1984	1985	1986
	(millions)					
Balance--beginning of year	$457.2	$404.5	$351.7	$298.9	$246.2	$193.4
Writeoff of plant and fuel	(59.0)	(59.0)	(59.0)	(59.0)	(59.0)	(59.0)
Reduction in accumulated deferred taxes	6.3	6.3	6.3	6.3	6.3	6.3
Balance--end of year	404.5	351.7	298.9	246.2	193.4	140.7
Return on investment:						
End of year balance:	404.5	351.7	298.9	246.2	193.4	140.7
Rate of return	.1180	.1219	.1246	.1276	.1299	.1312
Total	47.7	42.9	37.2	31.4	25.1	18.5
Revenue requirement	102.6	92.2	80.1	67.6	54.0	39.7

Table 24

Net Revenue Requirement Increases With Zion out of Service: Return on Investment Allowed and 10-Year Writeoff of Plant

Year	3-percent load growth	1.5-percent load growth
	(millions)	
1981	$356.0	$354.9
1982	296.0	302.7
1983	291.7	269.9
1984	267.7	221.3
1985	231.7	165.6
1986	281.8	195.5

Increased financing costs could result from closing Zion

Revenue requirements could be increased beyond our estimates if investors demand a higher risk premium on Commonwealth Edison's securities if Zion is closed prematurely. A relatively small

increase in the interest rate on long-term bonds could greatly increase revenue requirements in future years, particularly when Commonwealth Edison's need for large amounts of capital for its new nuclear units is considered. For example, a 1-percent increase in the interest rate on the $809 million in long-term financing planned for 1981 would amount to $8.1 million annually over the life of the security. Common stockholders could also demand a higher rate of return on their investment which, if granted, would further increase revenue requirements.

Any added costs due to higher interest rates or a higher rate of return on common stock will be heavily influenced by ICC decisions on how the costs of the Zion units would be treated in the rates if Commonwealth Edison is required to discontinue the Zion operations. Since there is no precedence for this kind of action, both ICC and investor responses are uncertain.

Decommissioning and spent fuel costs are still uncertain

Although a few small nuclear reactors have been decommissioned in the United States, no major facility the size of Zion has been decommissioned. Available cost estimates, therefore, are tentative and subject to a number of uncertainties. One major uncertainty is the method of decommissioning the units. One of three methods is usually considered in cost studies--mothballing the unit, in-place entombment, or dismantlement. Each method has its advantages and disadvantages and related costs. Mothballing, for example, has the lowest initial cost but requires continuous surveillance. In-place entombment goes a step further than simple mothballing, but also requires continuous security measures. Both of these methods also limit the use of the site for any purpose. Dismantlement involves removal and disposal of all radioactivity in excess of levels which would permit release of the facility for unrestricted use. Dismantlement has the highest initial cost but effectively clears the powerplant site for other uses. This decommissioning method is estimated to require 6 years, including 2 years for planning.

Based on studies sponsored by NRC, Commonwealth Edison estimates that decommissioning the two Zion units using the dismantlement method would cost, in 1981 dollars, $112.6 million. At the end of 1980, Commonwealth Edison had collected $24.4 million for decommissioning costs as part of its depreciation expense. In addition, the company had collected $15.4 million for interim chemical cleaning of the Zion units. The net decommissioning costs, then, would be $72.8 million ($112.6 million less amounts collected for decommissioning and chemical cleaning). Since decommissioning is estimated to take 6 years, the final costs incurred would be higher as costs increase due to inflation.

Disposal costs for removing the spent nuclear fuel are closely linked to the timing of the decommissioning process. The spent fuel is presently stored onsite until such time as it can be can be transferred to a final respository--either permanent storage or a reprocessing plant. Current production costs for Zion include an amount for spent fuel disposal based on permanent storage. If Zion were shut down in the near future and dismantled, all the spent fuel stored onsite would have to be moved. Since there is no permanent disposal site currently designated, a temporary site would have to be designated, and the spent fuel would have to be moved and stored at an intermediate location and transferred later to a permanent site.

Through provisions added to nuclear fuel expense, Commonwealth Edison had recovered, as of December 31, 1980, $31.8 million for the eventual disposal of Zion's spent fuel. However, the total costs to dispose of the spent fuel plus the fuel in the reactors would be much higher for the following reasons:

--The spent fuel provision was based on lower disposal costs per kilogram than current estimates.

--The unused fuel in the reactor must be treated as spent fuel for disposal purposes.

--The provision for spent fuel was made assuming permanent disposal costs only. With Zion out of service early, costs for temporary storage also could be incurred.

Based on Department of Energy (DOE) estimates, 1/ total costs for temporary storage and then permanent disposal would be $198 million in 1981 dollars. For permanent disposal only, the cost is estimated at $133 million. The additional costs for temporary storage away from the reactors could be avoided by keeping the fuel at the Zion site until permanent disposal facilities are available some time in the future. This would, however, delay complete decommissioning of the Zion site.

IMPACT ON RATEPAYERS DEPENDS ON REVENUE REQUIREMENTS

Although our projected revenue requirement increases with Zion out of service are substantial, spreading these costs over

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1/The one-time cost for temporary storage and permanent disposal is estimated at $503 per kilogram. For disposal only, the estimate is $339 per kilogram. At the end of 1980, about 221,000 kilograms of spent fuel were being stored at Zion and 172,000 kilograms of fuel were in the reactors. Subsequent refuelings increase the amount of spent fuel and the estimated disposal costs.

Commonwealth Edison's large electric sales base limits the impact on a kWh basis. Average cost per kWh would increase between 1.7 percent and 9 percent, depending on the year and the assumptions used. Table 25 shows projected costs per kWh for the years 1981 through 1986 with Zion in service. Table 26 shows increased costs per kWh without Zion.

Table 25

Projected Cost per Kilowatt Hour--Zion in Service

(3-Percent Load Growth)

Year	Revenue requirements	Sales	Cost per kilowatt hour
	(millions)	(megawatt hours)	(cents)
1981	$3,943.7	64,900,000	6.08
1982	4,777.8	67,100,000	7.12
1983	5,336.7	69,000,000	7.73
1984	5,810.1	71,000,000	8.18
1985	6,526.1	73,400,000	8.89
1986	6,893.6	75,900,000	9.08

Table 26

Projected Increased Cost per Kilowatt Hour--Zion out of Service

(3-Percent Load Growth)

	No return on investment, no plant writeoff		No return on investment, 10-year plant writeoff		Return on investment, 10-year plant writeoff	
	Increase	Total	Increase	Total	Increase	Total
	(cents)					
1981	0.29	6.37	0.39	6.47	0.55	6.63
1982	0.21	7.33	0.30	7.42	0.44	7.56
1983	0.21	7.94	0.31	8.04	0.42	8.15
1984	0.19	8.37	0.28	8.46	0.38	8.56
1985	0.15	9.04	0.24	9.13	0.32	9.21
1986	0.23	9.31	0.32	9.40	0.37	9.45

LONG-TERM REVENUE REQUIREMENTS INCREASE SUBSTANTIALLY

Increased revenue requirements resulting from increased production costs extend beyond 1986, but with assumed price/cost escalation increasing the dollar amounts substantially. The effects of changes in generating capacity construction that would result from closing Zion are evident only to a minor degree from 1981-1986.

Any new units constructed will cost substantially more than the units being replaced. The Zion units, constructed during the late 1960s and early 1970s, have a cost of about $300 per kilowatt of capacity. For its long-term planning, Commonwealth Edison projects that generating capacity installed in the early 1990s will cost a minimum of $1,500 per kilowatt.

Without Zion service dates for new units now tentatively planned for the 1990s would be accelerated 1 to 4 years depending on the load growth assumption. Closing Zion would also result in construction of 2,150 more megawatts of capacity than would otherwise be required. Table 27 shows projected service dates for new capacity with and without Zion.

Table 27

Projected New Capacity Service Dates

	3-percent load growth			1.5-percent load growth		
Year	Zion in	Zion out	Difference	Zion in	Zion out	Difference
	(megawatts)					
1990	-	1,100	1,100	-	-	-
1991	550	1,350	800	-	-	-
1992	550	1,350	800	-	-	-
1993	1,100	-	(1,100)	-	-	-
1994	800	1,350	550	-	800	800
1995	1,350	1,350	-	-	800	800
1996	550	550	-	-	-	-
1997	1,350	1,350	-	-	550	550
1998	1,350	1,350	-	800	550	(250)
1999	1,100	1,100	-	800	800	-
2000	1,100	1,100	-	550	800	250

At our request, Commonwealth Edison projected total revenue requirement increases through the year 2000, assuming the Zion units were taken out of service in 1981. Table 28 shows the projections under the alternate growth assumptions. In these projections, costs of the Zion plant are treated as sunk

costs--depreciation expense and return on investment continue as they would with Zion in service. Also, decommissioning costs are included in 1984 revenue requirements. The projections will, therefore, differ from our 1981-86 projections discussed earlier.

Table 28

Total Revenue Requirement Increases--
Zion out of Service

Year	3-percent load growth	1.5-percent load growth
	-------------(millions)	-------------
1981	$ 312.3	$ 311.2
1982	269.2	275.9
1983	283.3	261.6
1984	397.6	351.2
1985	253.9	187.7
1986	325.7	239.4
1987	408.8	245.5
1988	460.6	281.2
1989	467.0	338.3
1990	707.3	416.2
1991	1,100.1	499.4
1992	1,351.7	618.4
1993	1,359.3	818.7
1994	1,379.0	1,146.9
1995	1,378.6	1,405.6
1996	1,474.4	1,660.1
1997	1,428.8	1,867.3
1998	1,621.5	1,728.7
1999	1,416.9	2,022.5
2000	1,798.4	1,906.4
Total	$18,194.3	$16,582.3

Some qualifications to the meaning of these projections should be noted. Costs are assumed to escalate at 9 percent annually, which has a significant effect on long-range projections. With 9-percent escalation, $1.00 in 1981 is equal to $2.37 in 1990 and $5.60 in 2000. In constant dollar terms, therefore, the revenue requirement increases shown in table 28 would be considerably lower.

Another qualification to these long-term projections is that Zion's capacity will eventually have to be replaced anyway. If the useful life turns out to be 30 to 35 years, then Zion will have to be replaced some time between 2004 and 2009. Coal-fired capacity added in the 1990s to replace Zion would, assuming a 40-year life, be in service into the 2030s. Therefore,

construction costs for these plants in the 1990s would replace construction costs in the first decade of the 21st century. This effect would be more pronounced under the 1.5-percent load growth assumption where the replacement capacity comes into service a few years later.

Lastly, the revenue requirement increases in table 28 do not reflect future additions to the Zion plant. Additions totaling nearly $138 million are projected for 1981 through 1985 with an additional $38 million proposed for 1986. Presumably, further additions can be expected in future years. With Zion out of service, the revenue requirements for return on investment and depreciation of these additions could be avoided. Should NRC impose substantial additional safety requirements, the impact of plant additions avoided with Zion closed would be more pronounced.

CLOSING ZION WOULD HAVE OTHER FINANCIAL EFFECTS

Closing Zion would have other financial effects not included in the revenue requirement projections. Commonwealth Edison would incur losses on fuel commitments and would have to accelerate spending on transmission system improvements, local governments around Zion would lose tax revenue and employment, and NRC's workload could increase as Zion is decommissioned.

Losses related to future fuel requirements

Included in the revenue requirements effects discussed earlier are losses on unused fuel in the Zion reactors. Additional losses would be incurred on commitments for future fuel needs. Commonwealth Edison personnel estimated that, as of June 1981, these losses would total $28 million. Losses of $20 million would be incurred for two refuelings scheduled for late 1981 and early 1982, assuming a $25-million cost per refueling and $15-million salvage value. No losses would be incurred for uranium enrichment because the contracts are of the requirements type. However, a $5-million penalty would be incurred to cancel the conversion contract. Lastly, carrying charges would increase by $3 million as uranium intended for Zion fuel would be used elsewhere at a later date. Had Zion been closed at the beginning of 1981, losses would have been incurred on refueling that took place in early 1981.

Accelerated transmission projects

With Zion out of service, Commonwealth Edison's transmission system would be stressed (See page 55). Although no additional transmission facilities--other than ones already planned--would be required, completion dates for 10 projects currently requiring completion between 1985 and 1998 would be moved up between 1 and 5 years. The costs for these projects--$495 million--would correspondingly be incurred sooner than now planned.

Local community effects

Commonwealth Edison currently pays about $12 million in property taxes on the Zion plant. Actual taxes paid for 1979 on the plant, excluding the land, are shown in table 29.

Table 29

1979 Property Taxes on Zion Plant

Taxing body	Amount (thousands)
Lake County	$ 937.6
Forest Preserve District	315.6
Zion Township	239.9
City of Zion	1,463.6
High School District	3,420.0
Junior College District	387.6
Library District	275.0
School District	3,528.9
Sanitary District	1,221.8
Park District	795.5
Total	$12,585.6

Source: Commonwealth Edison Company.

If Zion were to close, Commonwealth Edison would still pay taxes on the land but not on the plant because it would have no value. Closing Zion would also affect local employment; about 400 people now work at the plant.

NRC oversight

NRC currently has two full-time inspectors in residence at Zion. With Zion closed, these inspectors eventually would not be required; however, because of decommissioning, NRC staff needed in the initial years after closure could increase substantially.

LIMITING ZION TO 70-PERCENT POWER CHANGES GENERATING MIX, PRODUCTION COSTS, AND REVENUE REQUIREMENTS TO A LESSER DEGREE

Continued operation of the Zion units at a reduced power level is an option to total shutdown. Running nuclear reactors at reduced operating power levels can, according to one NRC

study, 1/ reduce the potential consequences of an accident and reduce the probability of an accident occurring or running its course. Commonwealth Edison engineering staff, however, stated that operating at reduced capacity provides little or no reduction in the probability of accidents, and only a small reduction in the consequences of an accident. Further, they stated that operating the units at less than the design capacity could cause performance problems, resulting in more forced outages. Our review did not address these safety and technical issues. We analyzed only the cost impact of operating at reduced power.

Generation and purchases change with Zion at 70-percent power

With the Zion units limited to 70-percent power, fossil-fueled generation and power purchases increase, although not to the extent that would occur with Zion out of service. Tables 30 and 31 show the source and quantity of energy under the alternate growth rates. Changes in fossil fuel use quantities are shown in tables 32 and 33.

Table 30

Projected Electric Generation and Purchases--Zion at 70-Percent Capacity

(3-Percent Annual Load Growth)

Source of generation	Megawatt hours 1981	1982	1983	1984	1985	1986
	-----(000 omitted)-----					
Nuclear	23,757	28,274	36,161	41,918	47,148	53,055
Coal	30,227	28,674	26,150	25,886	24,649	23,381
Steam-oil	6,696	5,929	5,923	5,958	5,943	3,301
Peakers-oil and gas	579	117	110	118	115	150
Total generated	61,259	62,994	68,344	73,880	77,855	79,887
Purchases	7,734	8,320	5,064	1,703	219	891
Total available	68,993	71,314	73,408	75,583	78,074	80,778

Source: Commonwealth Edison Company.

1/"Report of the Task Force on Interim Operation of Indian Point," Secy-80-283, June 12, 1980.

Table 31

Projected Electric Generation and Purchases—Zion at 70-Percent Power

(1.5-Percent Annual and Load Growth)

Source of generation	1981	1982	1983	1984	1985	1986
	Megawatt hours (000 omitted)					
Nuclear	23,757	28,272	36,080	41,652	46,612	51,891
Coal	30,174	29,038	26,487	23,734	20,210	19,650
Steam-oil	6,569	5,943	5,949	5,917	5,933	2,452
Peakers-oil and gas	536	112	103	59	37	42
Total generated	61,036	63,365	68,619	71,362	72,792	74,035
Purchases	7,687	5,852	1,841	83	51	437
Total available	68,723	69,217	70,460	71,445	72,843	74,472

Source: Commonwealth Edison Company.

Table 32

Increased (Decreased) Fossil Fuel Use-- Zion at 70-Percent Power Level

(3-Percent Annual Load Growth)

Year	Coal (tons)	Number 6 oil (barrels)	Gas (therms)	Number 2 oil (gallons)
	(000 omitted)			
1981	38	(69)	8,339	1,491
1982	(457)	(82)	(6,144)	(2,302)
1983	(240)	(51)	(621)	(3,800)
1984	576	21	-	2,195
1985	1,254	38	-	3,760
1986	901	635	-	5,011

Source: Commonwealth Edison Company.

Table 33

Increased (Decreased) Fossil Fuel Use--
Zion at 70-Percent Power Level

(1.5-Percent Annual Load Growth)

Year	Coal (tons)	Number 6 oil (barrels)	Gas (therms)	Number 2 oil (gallons)
	----------------	---(000 omitted)---	----------------	
1981	39	11	6,143	1,329
1982	238	(52)	(2,358)	(1,217)
1983	828	24	136	883
1984	1,330	54	-	2,163
1985	1,167	25	-	1,420
1986	866	293	-	1,724

Source: Commonwealth Edison Company.

Production costs and revenue requirements increase with Zion at 70 percent power

With Zion limited to operation at 70-percent power, increased costs would not be as high as those with Zion out of service because less capacity and generation would need to be replaced. Production cost increases under the two growth assumptions are shown in table 34. Under the 70-percent power assumptions, there are only minor savings for operation and maintenance costs since the plant is kept running.

Table 34

Production Cost Increases--
Zion at 70-Percent Power Level

Year	3-percent load growth	1.5-percent load growth
	-----------(millions)	----------
1981	$ 65.4	$ 66.6
1982	63.0	64.3
1983	68.9	62.3
1984	71.8	57.2
1985	62.9	49.4
1986	83.8	57.3

Net revenue requirement increases from these cost increases are shown in table 35.

Table 35

Revenue Requirement Increases--
Zion at 70-Percent Power

Year	3-percent load growth	1.5-percent load growth
	------------(millions)	-----------
1981	$ 71.1	$ 72.4
1982	68.5	69.9
1983	74.9	67.7
1984	78.5	62.2
1985	69.3	53.6
1986	91.2	62.3

As in the cases with Zion out of service, long-term revenue requirement changes with Zion at 70-percent power also reflect the effect of accelerated construction to replace the lost capacity. Under the 3-percent growth assumption, increased revenue requirements from 1981 through 2000 resulting from limiting Zion to 70-percent power are projected to total $5.3 billion. Using the 1.5-percent increase, the projected total is $4.3 billion.

CHAPTER 4

GENERATING AND TRANSMISSION RELIABILITY

DETERIORATE WITHOUT ZION

The loss of the Zion units' 2,080-megawatt capacity--over 12 percent of Commonwealth Edison's current summer capability--would seriously affect the company's ability to maintain sufficient generating capacity to ensure adequate electric service reliability. Unless Zion's capacity can be made up through some other measures, its loss would reduce generating reserve margins below acceptable levels. Depending on load growth, the reserve levels could be considered unsatisfactory through 1990.

The primary aim of a utility company is to have enough generating capacity to meet its peak load plus adequate reserves to meet planned and unscheduled outages, system operating requirements, and unforeseen loads. Because of Commonwealth Edison's extensive interconnections with neighboring utilities, the company has a relatively low reserve objective of 15 percent of the summer peak load. With Zion in service, the company projects that future reserve margins will be near or will exceed the reserve criteria. Without Zion, and assuming 3-percent annual load growth, reserve margins would fall below 10 percent each year from 1981 through 1984. From 1985 through 1990 the margins would be below the 15-percent criterion in all years but one.

If load growths are not as high as the 3-percent annual rate Commonwealth Edison now projects, the deficits in reserve margins would be less severe and of shorter duration. On the other hand, Commonwealth Edison projects that from 1982 through 1987, one large nuclear unit will be added each year to the company's summer capacity. Should the service dates for these units be delayed, Commonwealth Edison's capability to meet the critical summer peak loads would be further reduced. In some circumstances, the company's generating capability would not be sufficient to meet the projected load, much less provide a margin of reserve.

Closing Zion would also reduce Commonwealth Edison's interchange capability with other systems, increase transmission losses, and reduce service reliability. Increased power purchases by Commonwealth Edison to replace Zion's capacity could impair power import and supply reliability in Wisconsin, as well.

This chapter discusses the reliability effects of closing Zion, given Commonwealth Edison's current generating capacity and planned capacity additions. Chapter 5 analyzes how the capacity deficit could be made up.

COMMONWEALTH EDISON FOLLOWS MAIN'S RELIABILITY CRITERIA

Commonwealth Edison is a member of the Mid-America Interpool Network Regional Reliability Council and is directly interconnected with other MAIN members. Commonwealth Edison is also interconnected with utility companies in two other Regional Reliability Council areas as shown in figure 1 on page 46.

As a member of MAIN, Commonwealth Edison voluntarily subscribes to system planning and operating guidelines intended to improve and maintain the reliability of the electric power supply within the MAIN region. Commonwealth Edison also has certain broad obligations to the vast Eastern Interconnected System ranging from the Rockies to the east coast.

When associated with electric power systems, reliability is a broad term including generation, transmission, and distribution subsystems, and no single definition has as yet been accepted. Over the years, the more narrow reliability analysis of a power system's generation capability has resulted in more or less standard methodologies and criteria which attempt to establish sufficient generation reserves. The methodology most widely used centers on the loss of load probability (LOLP)--the probability that some portion of the load will not be satisfied by the generating capability--with a LOLP index of 0.1 days per year (sometimes translated into 1 day in 10 years) as the generally accepted criterion.

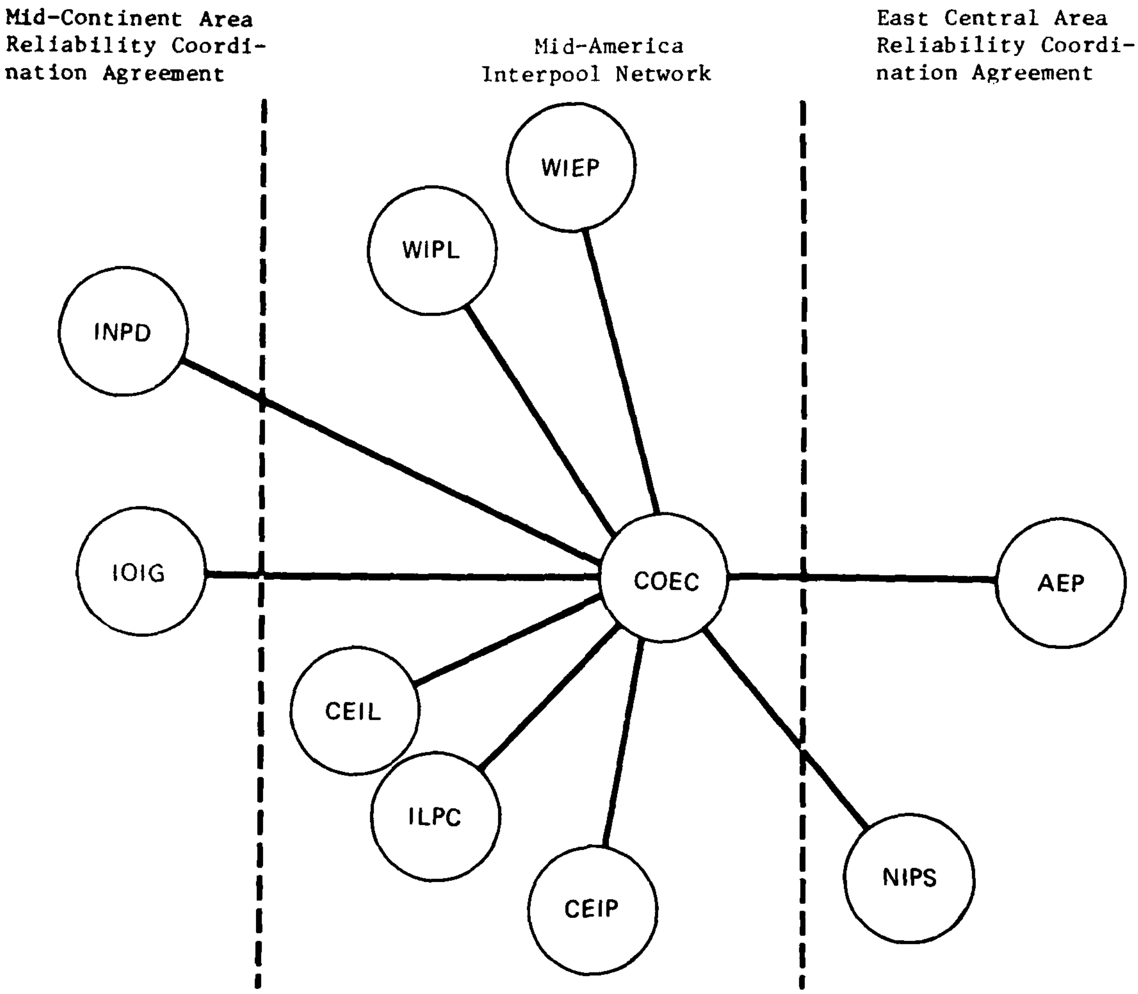
MAIN sets forth the procedure for determining generation reserve requirements for the region as a whole. This includes the LOLP method of analysis and a LOLP criterion of 0.1 day per year. The most recent MAIN generation reliability study shows reserves of 20.3 percent for MAIN isolated and 16.7 percent for MAIN interconnected with other systems for the 1989 planning year. These reserve margins reflect load forecast uncertainty due to weather and result in a LOLP index of 0.1 day per year. For planning purposes, MAIN could expect reserve help from its interconnections with neighboring utilities in the amount equivalent to 3.6 percent of its peak load.

The MAIN reliability study confirms its 1976 interim policy of a minimum 15- to 20-percent reserve for MAIN as a whole. Commonwealth Edison accepts the MAIN minimum 15-percent reserve criterion as its own. Generally, moderate to large systems in the electric utility industry plan for reserve capability ranging between 15 to 25 percent of annual peak loads. Those systems which plan reserves on the low end of the range usually have

Figure 1

Neighboring Interconnected System

of Commonwealth Edison



COEC - Commonwealth Edison Co.
WIEP - Wisconsin Electric Power Co.
WIPL - Wisconsin Power & Light Co.
INPD - Interstate Power Co.
IOIG - Iowa-Ill. Gas & Electric Co.
CEIL - Central Ill. Light Co.
ILPC - Illinois Power Co.
CEIP - Central Illinois Public Service Co.
NIPS - Northern Indiana Public Service Co.
AEP - American Electric Power Co., Inc.

significant hydrogeneration resources with their highly reliable characteristics or can rely on reserves from neighboring systems through numerous strong interconnections. Commonwealth Edison has 28 high-voltage interconnections ranging up to 765,000 volts with 9 neighboring utilities.

RESERVE MARGINS WITH ZION IN SERVICE ARE ADEQUATE

Commonwealth Edison has a total of 125 generating units (including 90 peaking units). These units, plus rights to pumped storage capacity, will provide the company with the 1981 summer capability shown in table 36.

Table 36

1981 Summer Generating Capacity

Type of unit	Capability	Percent of total capability
	(megawatts)	
Nuclear	4,778	28
Coal	6,937	41
Steam-oil	3,248	19
Peakers-oil and gas	1,277	8
Pumped storage	624	4
Total	16,864	100

Commonwealth Edison projects that reserve capability from its own generating units will not be adequate to meet its reserve margin criteria in 1981 and 1982. Consequently, firm purchase contracts for 300 megawatts are planned for those years to bring the reserve close to the desired 15 percent. Table 37 shows past and projected capacities, peak loads, and reserve margins using the company's current schedule of unit additions and peak load growth at 3-percent annually.

Table 37

Reserve Margins--1977-80 Actual, 1981-90 Projected

Year	Total capacity	Peak load	Reserve margin
	(megawatts)	(megawatts)	(percent)
1977	17,169	13,932	23.2
1978	17,480	13,720	27.4
1979	18,148	13,804	31.5
1980	a/17,033	14,228	19.7
1981	17,164	15,000	14.4
1982	18,212	15,600	14.8
1983	18,648	16,050	16.2
1984	19,768	16,550	19.4
1985	20,888	17,050	22.5
1986	21,950	17,550	25.1
1987	23,265	18,100	28.5
1988	22,953	18,650	23.1
1989	22,953	19,200	19.5
1990	22,953	19,800	15.9

a/Adjusted to reflect reductions in stated generating capacity of 620 megawatts at eight fossil stations and 233 megawatts at peaking units made in October 1980 resulting from an engineering review of unit capabilities.

Source: Commonwealth Edison Company.

The above future peak loads are Commonwealth Edison's official projections, assuming 3-percent annual load growth. If the load grows at an annual rate of 1.5 percent, reserve margins will be higher, as shown in table 38.

Table 38

Estimated Reserve Margins-- 1.5-Percent Annual Load Growth

Year	Total capacity (megawatts)	Peak load (megawatts)	Reserve margin (percent)
1981	17,164	14,950	14.8
1982	a/17,912	15,150	16.3
1983	18,648	15,400	21.1
1984	19,768	15,650	26.3
1985	20,888	15,900	31.4
1986	21,950	16,150	35.9
1987	23,265	16,400	41.9
1988	22,953	16,650	37.9
1989	22,953	16,900	35.8
1990	22,953	17,150	33.8

a/Does not include 300 megawatts of firm purchases as does the projection at 3-percent growth as shown in table 37.

Source: Commonwealth Edison Company.

The growth in Commonwealth Edison's total capacity and reserve margins will result from the capacity added by large nuclear units now under construction. Table 39 below analyzes projected capacity.

Table 39

Changes In Summer Capability

Year	Company-owned capability at begining of year	Pumped storage	Nuclear unit added	Firm purchases	Firm sales	Net capacity
	(megawatts)					
1981	16,240	624	-	300	-	17,164
1982	16,240	624	1,048	a/300	-	18,212
1983	17,288	312	1,048	-	-	18,648
1984	18,336	312	1,120	-	-	19,768
1985	19,456	312	1,120	-	-	20,888
1986	20,576	312	b/1,287	-	225	21,950
1987	22,863	312	1,090	-	-	23,265
1988-90	22,953	-	-	-	-	22,953

a/This purchase would not be made under the 1.5-percent load growth assumption.

b/Includes 197 megawatts for Dresden 1, an older nuclear unit now out of operation but expected to be returned to service.

Projected reserve margins peak in 1987 with the completion of the current nuclear plant construction program. In following years, the margins decline as peak load growth outstrips plant additions and older generating units are retired. Projected margins for 1990 through 1995 are shown in table 40.

Table 40

Projected Reserve Margins, 1990-95

Year	Official estimate-- 3-percent annual growth	1.5-percent annual growth
	(percent)	
1990	15.9	33.8
1991	15.2	31.9
1992	14.5	30.0
1993	16.2	28.2
1994	15.0	24.8
1995	16.1	21.2

Source: Commonwealth Edison Company.

Besides the nuclear units now being built, no additional generating units are scheduled for service before the 1990s. The company has tentative plans for additional coal-fired capacity in the early 1990s. It has also contracted for some equipment for two more nuclear units in the mid-1990s, although these units can be deferred or cancelled. The scheduling for construction of any additional units will depend on actual load growth.

RESERVE MARGINS WITHOUT ZION MAY NOT BE ADEQUATE

If sufficient replacement capacity cannot be obtained, closing Zion would cause reserve margins to fall below acceptable levels. The period during which reserves are less than the target level could extend through 1990, depending on load growth. Reserve margins without Zion under the alternative load growth assumptions are projected in table 41.

Table 41

Projected Reserve Margins Without Zion

Year	Capacity	3-percent load growth Peak load	Reserve	1.5-percent load growth Peak load	Reserve
	(megawatts)	(megawatts)	(percent)	(megawatts)	(percent)
1981	15,084	15,000	0.6	14,950	0.9
1982	15,832	15,600	1.5	15,150	4.5
1983	16,568	16,050	3.2	15,400	7.6
1984	17,688	16,550	6.9	15,650	13.0
1985	18,808	17,050	10.3	15,900	18.3
1986	19,870	17,550	13.2	16,150	23.0
1987	21,185	18,100	17.0	16,400	29.2
1988	20,873	18,650	11.9	16,650	25.4
1989	20,873	19,200	8.7	16,900	23.5
1990	a/21,973	19,800	11.0	17,150	21.7

a/Assumes coal-fired capacity of 1,100 megawatts added under the 3-percent growth assumption but not under the 1.5-percent growth assumption.

Operating reserves without Zion are impaired

In order to maintain continuity of electric supply, generation reserve capacity is needed to cover *lost capacity* in the event of unexpected outages of generating units, delays in construction of new generating units and unexpected loads due to extreme weather. Operating reserves are needed almost instantly to follow load variations and to replace lost capacity due to a forced outage. Operating reserves include spinning reserve--generating capacity which is synchronized to the system and ready to produce electricity immediately. Spinning reserve is essential for following load variations second by second. A portion of operating reserve may also consist of quick starting capacity which usually can be started, synchronized, and fully loaded within about 10 minutes. Combustion turbine peaking units fit this category.

Operating reserves should, as a general rule, be at least sufficient to cover the loss of capacity due to the largest single contingency on the electric system, usually the loss of the largest generating unit. As a member of MAIN, Commonwealth Edison must adhere to MAIN's guidelines. MAIN's minimum operating reserve is equal to 1.5 times the largest unit within the MAIN system. The minimum operating reserve is allocated among each subgroup within MAIN. 1/

1/Commonwealth Edison is considered a single subgroup. The other subgroups are Illinois-Missouri utilities and Wisconsin-Upper Michigan utilities.

For Commonwealth Edison, this allocation results in minimum operating reserve requirements of 3.2, 5.0, 4.2, 4.1, and 4.0 percent of the 1981 through 1985 peak loads, respectively. Considering the reserves at a 3-percent growth rate without Zion shown in table 41, Commonwealth Edison would not be able to meet the operating reserve needed during 1981, 1982, and 1983 peak periods. The company would, therefore, be expected to purchase power to make up the deficiency if Commonwealth Edison were to meet its obligation to the other MAIN members by maintaining the minimum operating reserve.

Finally, Commonwealth Edison has an obligation to the entire interconnected system to carry reserves. This obligation falls on any utility wishing to operate its system interconnected with others. Although this obligation is voluntary, reliability would deteriorate for all if some systems "leaned" on the interconnection in place of maintaining adequate reserves of their own. Reserves are absolutely essential for the successful interconnected operation of a power system. An individual system would place a burden on the interconnection by requesting emergency service from neighboring systems more frequently and in greater amounts then might otherwise be expected if its reserves met at least the minimum acceptable requirements.

Delays in nuclear plant construction program would increase capacity deficiencies

As previously discussed, six nuclear units are scheduled to be added to the summer capacity from 1982 through 1987. This new capacity will eventually bring reserve margins up to target levels, even with Zion closed. Should any of the units be delayed and not available for summer peak as scheduled, reserve margins would be further eroded, worsening the impact of losing Zion's 2,080 megawatts. Without Zion, and with each nuclear unit delayed 1 year, Commonwealth Edison's capacity would not even meet the peak load in some cases, as shown in table 42. With the new units delayed and Zion out of service, the additional capacity required to achieve the reserve margin objective could be as high as 3,128 megawatts, as table 43 illustrates.

Table 42

Projected Reserve Margins Without Zion and 1-Year Delay of Each New Nuclear Units

Year	Summer capacity	Reserve margin: 3-percent load growth	Reserve margin: 1.5-percent load growth
	(megawatts)	(percent)	(percent)
1982	14,784	a/(5.2)	a/(2.4)
1983	15,520	a/(3.3)	0.8
1984	16,568	0.1	5.9
1985	17,688	3.7	11.2
1986	18,780	7.0	16.3
1987	20,095	11.0	22.6

a/Negative percentages mean the peak loads exceed capacity.

Table 43

Additional Capacity Required to Maintain Reserve Margins with Zion out of Service and 1-Year Delay of Each New Nuclear Unit

	3-percent load growth			1.5-percent load growth		
Year	Without Zion	Nuclear unit delayed	Total	Without Zion	Nuclear unit delayed	Total
	(megawatts)			(megawatts)		
1981	2,080	NA	2,080	2,080	NA	2,080
1982	2,080	1,048	3,128	1,900	1,038	2,938
1983	1,900	1,038	2,938	1,150	1,040	2,190
1984	1,350	1,114	2,464	300	1,120	1,420
1985	800	1,120	1,920	-	597	597
1986	300	1,090	1,390	-	-	-
1987	-	720	720	-	-	-
1988	550	NA	550	-	NA	-
1989	1,200	NA	1,200	-	NA	-
1980	800	NA	800	-	NA	-

Delays in completing nuclear units are common

The service dates for nuclear units have been subject to delays caused by a variety of design, construction, financing, and regulatory factors. Table 44 shows the changes in service dates of nuclear units under construction.

Table 44

Scheduled Service Dates for Nuclear Units as Projected in Commonwealth Edison Financial Reviews

Report date	Projected service date (note a) LaSalle Unit 1	LaSalle Unit 2	Byron Unit 1	Byron Unit 2	Braidwood Unit 1	Braidwood Unit 2
Apr. 1, 1976	1978	1979	1980	1982	1981	1982
Apr. 1, 1977	1979	1980	1981	1982	1981	1982
Apr. 1, 1978	1979	1980	1981	1982	1981	1982
Apr. 1, 1979	1979	1980	1981	1982	1981	1982
Apr. 1, 1980	1980	1981	1982	1983	1983	1984
Apr. 1, 1981	1982	1983	1983	1984	1985	1986

a/Dates are the year put into service--not necessarily availability during the summer peak period for those years.

In its April 1981 financial review, the company reported that, because of construction and licensing uncertainties, LaSalle Units 1 and 2 might not be placed in service before the summer peak loads.

Reserve margins deteriorate to lesser extent with Zion at 70-percent power

The effect on reserve margins of limiting Zion to 70-percent power is not as severe as the effect of a complete shutdown, but reserve margins are still reduced below the target level of 15 percent, as table 45 shows. The loss of 30 percent of Zion's capacity would have a more pronounced effect should the service dates for the nuclear units be delayed.

Table 45

Projected Reserve Margins With Zion at 70-Percent Power

Year	Capacity	3-percent load growth Peak load	3-percent load growth Reserve	1.5-percent load growth Peak load	1.5-percent load growth Reserve
	(megawatts)	(megawatts)	(percent)	(megawatts)	(percent)
1981	16,540	15,000	10.3	14,950	10.6
1982	a/17,288	15,600	10.8	15,150	12.1
1983	18,024	16,050	12.3	15,400	17.0

a/16,988 megawatts, using 1.5-percent growth.

TRANSMISSION SYSTEM WOULD BE ADVERSELY AFFECTED BY LOSS OF ZION

Although systems are designed to withstand the loss of at least a single generating unit, major transmission facility, or some combination thereof, it is presumed that the outage w . be temporary in nature. Operating conditions are generally tolerable, if not normal, until the unit or facility is restored to service. Since the transmission system of a utility is designed in coordination with its generating facilities, a permanent shutdown of a major generating plant can stress the transmission system, conceivably beyond its design or intended capabilities.

Loss of a major plant, such as Zion, can cause a significant redistribution or alteration of flows on parts of the bulk power transmission system, particularly when it occurs in an already capacity-deficient region. The Zion station is located in an area with a system load of 3,400 megawatts with only 2,900 megawatts of generating capacity. Projected load growth for this area is the highest in Commonwealth Edison's service area, but the company believes siting limitations and environmental restrictions will make it almost impossible to install additional generating units in that area. Consequently, the loss of Zion's 2,080 megawatts would increase the imbalance between load and generation, requiring additional power transfers from remote sources.

To make up for the loss of Zion's capacity, Commonwealth Edison would attempt to purchase power from neighboring utilities. The company's analysis of its transmission system indicates that, although existing interconnections are adequate to permit power imports of up to the full 2,080 megawatts of replacement capacity, the energy transfers from neighboring utilities could be limited because of the additional stresses that would occur within the company's transmission network. The completion dates for 10 major transmission reinforcement projects would have to be advanced to avoid overloaded facilities. These projects would require repair, replacement, or installation of transformers; 345,000 volt line construction; or raising of towers to correct for line-sag limitations. Six projects could be completed when needed. Three of the projects would need to be completed in 1981, but one could not be completed before 1982 and two could not be completed before 1984. This would require opening 138,000-volt lines during peak periods, thereby reducing reliability of service. Another project, needed in 1981 but not completable before 1985, would require dropping load.

Shutting Zion down would also increase system losses due in part to increased power imports and higher system loading.

Impaired power supply to eastern Wisconsin

Calculations made by the Wisconsin Public Service Corporation indicate that possibly the most serious impact of a shutdown of the Zion plant, aside from its effect on transmission and available reserves of Commonwealth Edison, would concern the transmission path from Northern States Power Company in Minnesota to Wisconsin Public Service Corporation, and from there to Wisconsin Electric Power and Commonwealth Edison. A prevailing bias flow has existed in recent years in the direction from Minnesota to Commonwealth Edison which, it is believed, would be accentuated by a shutdown of Zion. Wisconsin Public Service estimates that this would decrease the emergency transfer capability from Minnesota to the Wisconsin-Upper Michigan systems from its present value of 300 to 350 megawatts to 150 to 200. Since the Wisconsin-Upper Michigan systems are net exporters to Commonwealth Edison, they consider Minnesota (Northern States Power, in particular) as their primary source of relief in case of emergency, and this increased bias flow would directly impair the availability of that power supply. In addition, it would curtail the availability to the Wisconsin-Upper Michigan systems of economic hydroelectric energy from Northern States Power which it imports over its 500,000-volt tie with Manitoba (Canada) Hydro. This circumstance illustrates the impact a major plant shutdown can have on transmission ties and remote systems several hundred miles away.

CHAPTER 5

AVAILABLE OPTIONS VARY IN EFFECTIVENESS AND FEASIBILITY

If Zion were to close, several options could be implemented to deal with the capacity deficiency that would result. Immediately available options are to purchase power from other utilities to replace Zion capacity and to operate with reduced reserves. Options that have potential for the long term, but that would not help in the early 1980s, are construction of replacement plants and concerted programs to reduce electric demand. Options that are probably not feasible or practical are converting Zion to coal use, increasing the use of high-sulfur coal, and operating Zion only during peak demand periods.

The response to Zion's loss could combine several actions. For example, available power could be purchased while the system is operated with reserves reduced to the extent purchases are not sufficient to attain desired reserve levels. Meanwhile, construction of replacement capacity could be accelerated or demand reduction programs intensified. Cost factors, actual load growths, and actual service dates for construction in progress will affect the appropriateness of these various options.

To the extent other utilities have power to sell, purchasing power would be the most immediate way to replace Zion's capacity. Commonwealth Edison would have to purchase as much as 2,080 megawatts of firm capacity in some years just to maintain its reserve margin objective. The projected reserves of neighboring utilities indicate that this amount may be available. Purchases of this magnitude would, however, strain Commonwealth Edison's transmission system and reduce power supply reliability in Wisconsin. If the company's current construction program is delayed, purchased power requirements could be further increased.

REPLACING ZION'S CAPACITY WITH PURCHASED POWER MAY BE POSSIBLE

Purchasing power from other utilities would be the most immediate method of replacing the capacity lost if Zion were shut down. Commonwealth Edison system planning staff said they would use this method to the extent possible. As discussed in chapter 4, existing interconnections with neighboring utilities can handle the additional 2,080 megawatts, although not without adverse effects on the company's transmission system. In addition, importing more power from the north would affect power supply reliability in eastern Wisconsin.

In estimating the cost effects of closing Zion (chapter 3), it was assumed that sufficient firm-purchase power would be available to either replace Zion's 2,080 megawatts or attain

the 15-percent reserve margin. The firm purchases required to meet this objective are shown in table 46.

Table 46

Firm Purchases Required Without Zion

Year	3-percent load growth	1.5-percent load growth
	----------(megawatts)----------	
1981	a/2,380	a/2,380
1982	a/2,380	1,900
1983	1,900	1,150
1984	1,350	300
1985	800	-
1986	300	-
1987	-	-
1988	550	-
1989	1,200	-
1990	800	-

a/Includes 300 megawatts planned for purchase with Zion in service.

Availability of purchased capacity

Commonwealth Edison has interchange power agreements with the nine surrounding utilities to which it is directly connected. Interchange agreements typically contain provisions for the purchase or sale of emergency and economy power. There may also be provisions for the purchase of short-term firm power, usually on a week-to-week basis. However, this power is typically on a "when, as, and if available" basis and therefore could not be expected to provide long-term (year-to-year) power that Commonwealth Edison would require in place of the power provided by Zion. Commonwealth Edison could also purchase power from other systems, but this would require "wheeling" through the neighboring systems (power from the remote systems would, in effect, be transmitted through the neighboring systems).

Table 47 shows projected summer reserves of the interconnected utilities for 1981 through 1986. The reserve capacity includes the installed capacity, as well as the net firm capacity purchases and sales. As shown in the table, the neighboring system reserve percentages in aggregate are expected to decrease in the next 3 years.

Table 47

Total Reserves of Nine Systems Directly Interconnected to Commonwealth Edison

Year	Peak load	Reserves	Reserve margin
	(megawatts)	(megawatts)	(percent)
1981	29,355	8,649	29.5
1982	30,500	7,171	23.5
1983	31,623	6,536	20.7
1984	32,356	7,152	22.1
1985	33,386	7,900	23.7
1986	34,473	7,810	22.6

Commonwealth Edison system planning staff said the company can now locate about 1,000 megawatts of firm power from neighboring systems and possibly others farther away for 1981 and 1982. After that, they were not sure what would be available. Although it is not possible to conclude what amounts of firm power will likely be available just by examining the neighboring system's reserves, the reserves shown in table 47 appear adequate, at least in 1981. With a total of 8,649 megawatts of reserve in 1981, there should be a good possibility that firm power will be available. The availability of power for purchase should increase if rates of load growth are further lowered for the region as they have been in recent years. On the other hand, delays in putting the nuclear units now under construction into service would add to the generating capacity deficit caused by closing Zion. Such delays could increase the amount of replacement power required, thereby decreasing the probability that all purchased power required would be available.

OPERATING WITH REDUCED RESERVES MAY BE NECESSARY

If firm power purchases or other measures do not make up for all the capacity deficit caused by a Zion shutdown, then Commonwealth Edison would simply be forced to operate its system during the critical summer peak periods with reserves below the 15-percent requirement. Operating an electric system with reduced installed reserves does not necessarily mean that reliability of the power supply will be reduced from the customers' point of view. It only means that there is an increased likelihood that the necessary operating reserves may not be adequate over the peak periods.

Commonwealth Edison would have to purchase emergency power from neighboring utilities should all the available capacity still not be enough to meet the minimum operating reserve requirement. Neighboring systems may feel that they are burdened

should Commonwealth Edison request emergency service more than might normally be expected. However, if the Zion plant were ordered to shut down, the circumstances surrounding the imposed burden would likely be better tolerated than if Commonwealth Edison were simply avoiding its responsibility for providing adequate reserves.

If neighboring systems have little or no emergency power to sell, Commonwealth Edison would then have to consider actions that would affect customer service. Table 48 shows load reduction options the company might put into effect. The stated megawatt reductions may vary, depending on the load at the time the program is implemented.

Table 48

Load Reduction Options

Option	Load reduction (megawatts)
Curtailment of nonessential utility system loads	10 to 25
Voltage reductions:	
2.5 percent	150
5 percent	300
Commercial and industrial customer voluntary response	1,000
Public appeal	500 to 1,000

Emergency purchases and the load reduction programs should not be a substitute for Zion replacement power, but they may be the only remaining alternatives. Such actions, however, can result in higher costs because emergency power is usually incrementally priced, and load reduction programs impose costs on customers from having to reduce or interrupt their electric service. These costs are highly unpredictable.

REDUCING ELECTRIC DEMAND HAS LONG-TERM POTENTIAL

A substitute for adding generating capacity to balance power supply and demand is to reduce the demand placed on utility generating facilities. In recent years, this alternative has received increasing attention as a way of avoiding construction of costly generating plants.

Conservation, load management, and cogeneration could conceivably reduce Commonwealth Edison's future loads by enough to offset the loss of Zion's 2,080 megawatts. This represents,

however, long-term load reduction potential, and it is doubtful that much could be done (other than the emergency load reduction measures discussed in the previous section) to reduce load in the early 1980s when the loss of Zion would be most critical. Further, the long-term, reasonably attainable savings depend on the cost effectiveness of specific measures, customer acceptance, economic conditions, and regulatory and other governmental policies.

Demand reducing techniques

Energy conserving measures make homes, businesses, and industrial processes more energy efficient--less energy is needed to produce essentially the same results. Typical conservation measures include improving residential insulation and weatherization, using more energy-efficient appliances, adjusting thermostats, modernizing production facilities, and recycling materials.

Load management is a technique used to reschedule electricity use to reduce peaks and valleys in the utility's load. Since the demand for electricity varies during the day and between seasons, electrical generating facilties are built and designed with enough capacity to meet the peaks--the times of heaviest demand on the system. Standby generators, used in most power systems to meet peak demands of short duration, are inefficient and expensive to operate. Load management can save consumers money by reducing the need for peaking generation and allowing utilities to meet more energy demands with economical baseload plants. Load management techniques include demand control, rescheduling use of electrical equipment from peak to off-peak hours, time-of-use rates, and interruptible service. Demand control involves limiting the use of appliances, such as air conditioners, during peak load periods. An example of rescheduling is cold storage--using electricity during off-peak hours to make ice that is used for cooling purposes during peak hours. Time-of-use rates--hourly and seasonal--are intended to reduce peak loads by increasing the price of energy consumed during periods of heavy demand. Under interruptible service, the utility is allowed to interrupt the customer's service during peak demand periods in exchange for lower rates.

Cogeneration is the combined production of electrical or mechanical power and process heat. Where electric energy and heat are both needed in the same facility, cogeneration has the advantage of producing the same amount of energy with less fuel than separate conventional steam and electrical systems. In a study prepared for the ICC, 1/ Temple, Barker and Sloane, Inc.,

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1/Temple, Barker and Sloane, Inc., "Electric Utility Rate Design for Cogenerators," December 1980.

estimated the technical potential in Commonwealth Edison's service area to be 425 megawatts, of which 148 megawatts 1/ would be economically justified. Temple, Barker and Sloane estimated potential market penetration at 15 megawatts in 1981 and 59 megawatts by 1987. This small market potential was attributed to a lack of steam-intensive industrial processes in the Chicago area.

Commonwealth Edison has special rates for solar-assisted space and water heating, but solar power for these uses is not expected to have much impact on the company's summer peak load.

The geography of the Commonwealth Edison service area is such that hydropower has limited potential. The company is, however, investigating an underground pumped storage facility. 2/ Generating equipment would be at the bottom of a 5,200-foot shaft and could have a capacity of as much as 2,000 megawatts. In conjunction with other utilities the company is also investigating compressed air storage in underground aquifers to power peaking or cycling generation, although it is uncertain if this is even technologically feasible.

Commonwealth Edison also has a project in cooperation with Chicago to burn the city's garbage with coal in the Crawford generating plant, but technical problems have prevented the project from working well. The potential of garbage as fuel is limited because most of the company's coal-fired units are not in high population areas.

Current conservation and load management programs

Commonwealth Edison's conservation objectives center on reducing the use of gas and oil for peak period generation and on deferring the need for expensive new generating capacity beyond the six nuclear units now under construction. The company has a strong summer-peaking system and the growth in summer peak load (basically, increased air conditioning use) has driven the company's need to construct new generating capacity. The company, therefore, emphasizes programs to minimize peak loads in order to decrease the need for capacity additions and to reduce energy costs by shifting loads to off-peak periods when costs are lower. Since gas- and oil-burning units are used mostly to meet peak load, shifting load to off-peak periods

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1/These amounts do not include an estimated 50 megawatts of generation already in use but not sold to Commonwealth Edison.

2/Pumped storage facilities use more electricity than they generate. However, they use electricity during nonpeak periods and generate it during peak periods, effectively increasing capacity available during peak periods.

has the effect of replacing gas and oil with the coal and nuclear fuel used by the baseload units that meet off-peak demand.

The company is using three strategies to meet these objectives:

--<u>Pricing</u>: seasonal, time-of-day, and interruptible rates.

--<u>Technology</u>: investigating and promoting demand control devices and off-peak ice storage used with air conditioning, for example.

--<u>Consumer education</u>: information dissemination, promotion of conservation, and promotion of shifting energy use to non-peak periods.

Commonwealth Edison's current load growth estimate of 3 percent (a reduction from previous growth rate projections) is meant to reflect conservation and load management measures, as well as economic and other conditions. However, all load management initiatives have not yet been specifically defined. Some programs are in the experimental stage, and the extent of customer acceptance of load management techniques has to be determined before the company can determine how much peak load can be reduced through conservation and load management.

Because Zion is operated as a baseload unit meeting the minimum part of electric demand, actions directed at peak load reductions would not significantly affect Zion's operation. To the extent that conservation, load management, and cogeneration measures would be implemented whether or not Zion remained in service, removing Zion would work against the objectives of reducing oil and gas use and deferring unit additions. Conservation and load management measures that would otherwise reduce oil and gas use and new capacity needs would instead replace Zion's capacity.

<u>Factors affecting alternatives to generating capacity</u>

Although there is significant technical potential for peak load reduction, projections of savings sufficiently realistic to base generating capacity decisions on are affected by many variables. Meeting demand by increasing generating capacity is a process where decisionmaking is centralized in the utility, subject to regulatory and other influences. Meeting demand by reducing load, however, is in large part contingent on policies outside the utility's control, as well as the individual decisions of thousands of electric consumers. Cost effectiveness of alternatives to generation capacity can be enhanced through electric pricing policies and subsidies. But even when a technique is

cost effective, the extent and speed of consumer acceptance are uncertain. The effectiveness of specific programs will also depend on the degree to which the programs are voluntary or mandatory.

A major policy shift toward alternatives to generating capacity requires many interrelated actions on the part of utilities and Government. These include

--demonstrating to the financial community that investments in alternatives are as credit worthy as investments in conventional powerplants;

--establishing economic and regulatory incentives to encourage industrial investments in cogeneration, load control, and energy-efficient equipment;

--developing comprehensive conservation programs, complete with environmental impact statements, energy audits, public involvement and outreach activities, and loans or subsidies; and

--establishing effective systems to monitor energy savings realized to ensure that they are sufficient to offset powerplant capacity.

NEW REPLACEMENT PLANTS CANNOT BE ADDED UNTIL THE 1990s

New coal-fired plants can be built to replace Zion's capacity, but would not be available for service before the 1990s. Construction of new oil-burning plants appears out of the question because of high fuel costs, as well as Federal restrictions on new oil-fueled generating units. 1/

Commonwealth Edison expects that closing Zion would eventually result in the construction of 2,150 megawatts of capacity more than would otherwise be required. Service dates for other units now tentatively planned would be advanced, but the first new units could not be put into service before 1990. Building a new coal-fired plant, including site selection, obtaining required permits, and actual construction, takes about 10 years. New coal plants, then, cannot help replace Zion's capacity during the 1980s, when reserve margins would be most critical.

Commonwealth Edison has contracted for some equipment for two additional 1,120-megawatt nuclear units in the mid-1990s.

1/Under the Powerplant and Industrial Fuel Use Act of 1978, oil cannot be used as the principal fuel in new generating units without the consent of the Department of Energy.

During the next several years it has the option to cancel or defer these units. Commonwealth Edison's three-fourth share of this capacity would replace most of Zion's capacity. As with new coal-fired plants, the new nuclear units could not replace Zion's capacity lost during the 1980s.

CONVERTING THE ZION PLANT TO COAL IS NOT PRACTICAL

One way to eliminate the radiological risks associated with a nuclear facility would be to convert the plant to coal use. However, many obstacles arise with converting the Zion units to burn coal:

--The Zion site, only 250 acres, is probably too small for a coal plant, given the amount of space required for coal stock, limestone, and the residue from coal combustion.

--Special environmental problems would result because of Zion's proximity to the city of Zion and location in the middle of Illinois Beach State Park.

--Salvaging much of the current equipment for use in a coal-fired generating system would probably not be feasible.

--In addition to the normal lead time for construction, it would also be necessary to decommission the present Zion facilities (remove radioactive materials), a process that is estimated to take 6 years. As with a new coal-fired plant, a converted Zion would not be available in the critically early 1980 period.

Replacing Zion's nuclear generation capability with coal-fired capability could more likely be accomplished by constructing new plants tentatively scheduled for the early 1990s than by converting Zion to coal.

USING HIGH-SULFUR COAL TO INCREASE CAPABILITY WOULD CAUSE ENVIRONMENTAL PROBLEMS

Commonwealth Edison could increase its generation by replacing the low-sulfur, low-energy coal currently used in its coal-fired units with the high sulfur, high-energy coal for which the units were originally designed. The total reduced capability due to burning low-sulfur coal was recently reported as 620 megawatts. For example, the two Powerton generating units were rated at 850 megawatts, but are now rated at 700 megawatts each.

A switch to high-sulfur coal, however, could not be made under current air quality restrictions. If emission limits for the coal plants were not relaxed, high-sulfur coal could still be burned if more pollution control equipment were installed. However, Commonwealth Edison officials do not consider this to be cost effective. Furthermore, pollution control equipment to remove sulfur consumes considerable energy and thus would, to some extent, defeat the purpose of using high-sulfur coal to increase generating capability.

INTERMITTENT OPERATION OF ZION UNITS POSES OPERATIONAL PROBLEMS

An alternative to closing Zion down completely would be to put the units in a cold shutdown condition during months of low electric demand, but operate the units during the summer peak period, or the summer and winter peak periods. The advantage of this option is that Zion's capacity would be available when it was most needed. It would alleviate the potential reliability of service problems identified in chapter 4 that could result from the lower summer reserve margin without Zion.

Since the Zion units are operated as baseload units, the loss of their low-cost generation, even during low demand periods, would increase the company's production costs. Commonwealth Edison engineering staff also identified a number of operational problems with this option, including

--additional maintenance procedures and equipment required;

--shortened operating life due to additional heat-ups and cool-downs of the reactor coolant systems;

--unavailability of the Zion units, due to their long startup times, in the event of an emergency caused by the loss of other generating capacity; and

--additional reactor operator training and probably additional staffing required.

During the extended shutdowns, the probability of some accidents would be reduced, but other safety concerns would surface, such as less redundancy of electric power generation and decay in heat removal systems.

NINETY-SIXTH CONGRESS

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CONGRESS OF THE UNITED STATES
HOUSE OF REPRESENTATIVES
SUBCOMMITTEE ON ENERGY AND POWER
OF THE
COMMITTEE ON INTERSTATE AND FOREIGN COMMERCE
WASHINGTON, D.C. 20515

April 10, 1980

The Honorable Elmer B. Staats
Comptroller General
General Accounting Office
441 G Street, N.W.
Washington, D.C. 20548

Dear Mr. Staats:

Recent studies of the March 18, 1979 accident at the Three Mile Island nuclear power plant have raised serious questions as to the advisability of siting nuclear facilities near large population centers. In their November 5, 1979 appearance before this Subcommittee, the Commissioners disclosed that the Nuclear Regulatory Commission was in the process of reviewing the present siting criteria, together with the past operational safety records of individual plants, and that, as a consequence of this review, certain nuclear plants may be required to install new safety equipment, or be derated or even cease operation altogether. The then Chairman of the Nuclear Regulatory Commission made specific reference to Consolidated Edison Company's Indian Point facility near New York and Commonwealth Edison Company's Zion plant near Chicago as examples of facilities which, because of their proximity to major population centers, may not be able to comply with additional safety requirements and may therefore cease operation.

In order to understand the economic consequences of such possibilities, we are requesting that your office undertake a comprehensive analysis of the comparative costs of terminating the operation of the abovementioned plants versus the cost of complying with additional safety requirements needed to adequately protect adjacent population. In conducting this analysis, we expect that you would include consideration of the following issues:

(1) What is the current cost to utility customers for operating these nuclear units? What additional capital improvements are being planned for these units? What other costs for maintaining these units will be borne by ratepayers? By taxpayers?

(2) What alternative actions are being considered to upgrade the safety of these plants in order to reduce the danger to nearby population centers? What is the estimated cost of each alternative?

(3) What is the feasibility and cost of establishing and maintaining an effective radiological emergency response plan at each of these facilities?

(4) What costs would be involved in closing down the units and how would these costs be covered and accounted for?

(5) If the units were closed, what steps would be necessary to provide adequate, reliable alternative power supplies? In answering this question, consider (among other factors):

(a) the historical down-time records of these units

(b) the reserve requirements of the respective grids of these units

(c) the availability and cost of replacement power

(d) the fuel source of alternative power supplies

(6) What role might government agencies play in mitigating potentially adverse effects of closing the plants?

In the course of conducting this analysis, we request that, whenever possible, you assess the impact of these particular costs on the utility, shareholder, ratepayer and taxpayer, and identify how they would be apportioned among each category. Furthermore, we understand that your office is presently studying the possibility of converting nuclear fueled plants to other forms of fuel. Because of this Subcommittee's interest in this issue, we ask that you keep us appraised of the progress of this study, and, wherever possible, include relevant information regarding Indian Point and Zion in this request, especially if the generic study is delayed beyond the anticipated release of our report. In the event that the generic study is not pursued, we specifically request that you include this alternative in the requested cost analysis.

The Subcommittee would also like to see these cost figures computed on a per ratepayer, per year basis for the remaining life of the individual units.

The Subcommittee recognizes the difficulties of performing the requested analysis, but believes the information obtained will materially aid the Subcommittee in carrying out its responsibilities. Given the current concern about nuclear safety issues, we would like to have your analysis by September 30, 1980. We further understand that to meet that date it may be necessary to complete the study of the Zion plant at a date later this year.

If you have any questions, please contact Mr. Michael Ward (225-1030) or Mr. David Gold (225-6506).

Sincerely,

John D. Dingell
Chairman

Richard L. Ottinger
Ranking Majority Member

JDD/jlc

METHODS AND ASSUMPTIONS USED TO PROJECT PRODUCTION COSTS WITHOUT ZION

Various methodologies and computer models are used to simulate electric production costs. The computer program used to simulate the production cost impact of a shutdown of the Zion nuclear plant for each year of the study period was the Energy Management Associates, Inc., probabilistic production-costing program. This program simulates the operation of Commonwealth Edison Company's system as a single area. A single-area simulation does not account for economy and emergency interchange opportunities with neighboring interconnected systems since the production costs of these systems are not concurrently simulated. However, firm purchases can be modeled by pseudo-generating units whose output represents the capacity and expected energy of the purchase. A firm sale may be represented by an equivalent increase in the single area's load. Economy purchases can also be simulated by a pseudo unit representing energy amounts which attempt to match historical economy purchases. Emergency purchases are made equal to the "unserved energy" which is a mathematical result of a probabilistic program. Economy sales and emergency sales apparently were not modeled in the single area simulation.

Commonwealth Edison operates its own control area--an electric power system to which a common generation control program is applied. The generation is controlled so that the Commonwealth Edison service area load is met second by second, while at the same time maintaining fixed hourly power flows to prearranged schedules with its neighboring systems. A multi-area production-costing simulation might be more appropriate if (1) Commonwealth Edison had integrated or "pooled" its operations with other systems, such that the control area encompassed these other systems, and (2) if there were internal transmission limitations between these systems. Since it has not pooled its operations with others, a single-area production simulation adequately fits the physical and operating situation of Commonwealth Edison.

The program computes production costs on a weekly basis. Commonwealth Edison uses its historical load shapes along with its peak load projections to develop the required input load data. The model requires as inputs the projected weekly load duration data broken into three separate load periods: the weekday peak period loads, the weekday off-peak period loads and the weekend loads. The primary reason for this centers on the simulation of Commonwealth Edison's use of the Luddington pumped storage plant in Michigan. Pumped storage plants require pumping typically during off peak periods during the week and on weekends. The plants then typically generate power during weekday peak periods.

Each week, generating units are committed for operations from the number of units available and not on predetermined scheduled maintenance. The unit commitment order is the order in which the units are loaded until the total load is met. The total generating capacity of the committed units should exceed the peak demand so as to cover the operating reserve requirements. The program takes into account each generating unit's expected forced outage rate or probability. A unit commitment order typically loads the baseload units (nuclear and large coal-fired steam plants), intermediate units (small coal-fired and oil-fired units), and peaking units (combustion turbines and pumped storage plants) in that order. The expected generation from each unit is always slightly less than would be available if the unit never experienced a forced outage. Conversely, every unit can be expected to generate some amount of power, even if it is the last unit (a peaking unit) committed and ordinarily would be used only for operating reserve. Also, a probabilistic costing model will compute an expected energy unserved. That is, there is always a possibility that some load will be unmet due to generator-forced outages.

Generating units are typically modeled by incremental heat rate curve, fuel type, fuel costs, maintenance costs, scheduled maintenance periods, and forced outage rates.

Study assumptions

The key assumptions in the production cost studies are discussed below:

A. Scenarios

Production cos were calculated assuming 1.5-percent and 3-percent annual load growth rates with Zion in service, out of service, and operated at 70 percent of power. Projections were made for the years 1981 through 2000.

B. Generating unit additions

The company's current schedule of additions for 1981 through 1989 is used for all scenarios. With Zion out or operated at 70-percent power, service dates for new coal-fired units are accelerated in the 1990s, and additional units are required. Service dates are later, and fewer new coal units are required under the 1.5-percent growth rate.

C. Purchased power

With Zion in service, Commonwealth Edison would purchase 300 megawatts of capacity in 1981 and 1982 under the 3-percent growth rate assumption. Only the 1981 purchase is required with 1.5-percent growth.

With Zion out of service or operated at 70-percent power, additional purchases are included in amounts necessary to either replace Zion's 2,080-megawatt capability or to achieve a 15-percent reserve margin, whichever is less.

Under all scenarios, economy purchases are simulated as a plant with 1,000 megawatts capacity.

D. Zion capacity factor

The capacity factors of the Zion units range from 47 through 69 percent, based on their projected availability, availability of other units, and system load.

E. Fuel and purchased power costs

Fuel and purchased power costs were based on January 1, 1981, replacement costs escalated at 9 percent per year. As of January 1, 1981, costs per megawatt hour were:

Nuclear	$ 8.2
High-sulfur coal	13.4
Low-sulfur coal	23.1
Number 6 oil	57.7
Natural gas	70.4
Number 2 oil	122.9
Purchases:	
Firm	21.0-27.0 (plus $4.50 per kilowatt-month demand charge)
Economy	38.5
Emergency	65.0

The fuel costs include a small component for variable operation and maintenance expense.

F. Zion operation and maintenance costs

Except for variable operation and maintenance costs included in the fuel costs above ($0.19 per megawatt hour for Zion as of January 1981), operation and maintenance costs were not modeled in the production cost simulations. Instead, Commonwealth Edison's rate case projections through June 1982 were used and extrapolated for future years, assuming 9-percent annual escalation.

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